5

THE ORGAN OF HEARING.

BY

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THE ORGAN OF HEARING.

RING, ORGAN OF. The ear (in the
eptation of the term). *Organon auditûs*
—Fr. *L'organe de l'ouie ou l'oreille.*
Das Gehörorgan oder das Ohr.—As
aratus of vision naturally admits of
vided into two parts, viz. the eye-ball
ppendages, so we can distinguish in
ratus of hearing a fundamental organ,
s accessory to the perfect performance
unction. The fundamental organ of
is what is commonly called the internal
rom the complexity of its structure, the
h. The accessory organs consist of the
ar or tympanum and external ear.*
extend our observations to the animal
nd trace the apparatus of hearing along
ending scale, we shall find that the
y parts gradually disappear, and that
of hearing comes at last to have for
merely a representative of the laby-
the higher animals. This part even,
laid aside much of its complicated
, presents itself under the form simply
mbraneous pouch containing a fluid,
calcareous concretion suspended in it,
ch the auditory nervous filaments are
ed.

labyrinth being in the apparatus of hearing exactly what the eye-ball is in that of vision, may be distinguished by the name of ***ear-bulb***. The ear-bulb, like the eye-ball, consists of a hard external case, in the interior of which are contained membraneous and nervous parts and humours. The accessory parts of the apparatus of hearing have also their prototypes in the accessory organs of the apparatus of vision.

The different parts of the apparatus of hearing are situated in the interior and on the surface of the temporal bone. See the description of the temporal bone in the article CRANIUM.

I.—THE EAR-BULB, *or fundamental organ of hearing.* (*Bulbe auditif*, Breschet.)

In man and the higher animals, the hard external case of the ear-bulb is of bone, and is called the *osseous labyrinth*. The soft textures contained in its interior bear the name of *membraneous labyrinth*. The interior of the osseous labyrinth, which we may with Breschet* call the *labyrinthic cavity*, is not completely filled by the membraneous labyrinth; the remaining space is occupied by a limpid watery fluid.

1. *The osseous labyrinth* (*labyrinthus osseus*; Fr. *Labyrinthe osseux*; Germ. *Das knöcherne Labyrinth.*)—The osseous labyrinth presents three compartments, distinguished by the names

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ghton, in Memoirs of the Medical Society
on, vol. iii. p. 7. London, 1792.

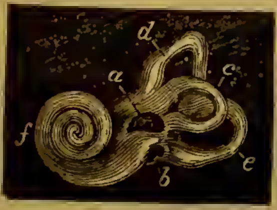
* Recherches anatomiques et physiologiques sur l'organe de l'ouie et sur l'audition, &c. chap. i. s. x. Paris, 1836.

of *vestibule*, *semicircular canals*, and *cochlea*. The semicircular canals and cochlea do not communicate immediately with each other, but only *mediately* through the vestibule. The latter may be considered the principal compartment.

The osseous labyrinth is imbedded in the substance of the petrous portion of the temporal bone, from the compact texture of which it is, in the adult, scarcely to be distinguished. In the early periods of life, however, its walls consist of a hard but brittle osseous substance, around which is the then less compact tissue of the petrous bone. Hence it is in a young bone only, and that by means of some little preparation, that the external form of the osseous labyrinth can be well demonstrated.

Of the compartments of the osseous labyrinth, the vestibule lies in the middle, the semicircular canals behind it, and the cochlea in front.

Fig. 1.



The exterior of the osseous labyrinth of the left side. Natural size.

a. Oval or vestibular fenestra; *b.* round or cochlear fenestra; *c.* external or horizontal semicircular canal; *d.* superior or anterior vertical semicircular canal; *e.* posterior or inferior vertical semicircular canal; *f.* the turns of the cochlea.

The vestibule, (vestibulum; Fr. *le vestibule;* Germ. *der Vorhof.)*—The vestibule is an irregularly shaped cavity, the diameter of which from above downwards, as also from behind forwards, may be stated to be about one-fifth of an inch. The distance between its inner and outer wall is somewhat more than one-tenth of an inch. In an anatomical sense we can distinguish in it three horns, one of which is towards the anterior and lower part, another towards the posterior and lower part, whilst the third composes the upper part of the vestibular cavity.

The anterior and lower horn leads by an oval opening directed forwards and downwards into the vestibular scala of the cochlea. This opening is called the vestibular orifice of the cochlea, *osteum s. apertura scalæ vestibuli cochleæ*. The posterior and lower horn of the vestibule corresponds to three of the orifices of the semicircular canals; the upper horn to the other two orifices.

At the under part of the inner wall of the vestibule, within the limits of its anterior horn and to the inside of the vestibular orifice of the cochlea, is a hemispherical depression, *fovea hemispherica s. sub-rotunda*. Its bottom, which corresponds to the posterior part of the lower depression at the bottom of the internal auditory meatus, presents a sieve-like spot, *macula cribrosa*, that is, it is perforated by minute apertures for the passage of filaments of the auditory nerve. On the upper wall of the vestibule, bordering the upper margin of the hemispherical fossa and within the limits of
upper horn, is another depression, of an
shape, which is known by the name of *f*
hemi-elliptica. The hemispherical and hem
liptical depressions are separated by a ridg
pyramidal eminence, *eminentia pyramid*
pervaded by small canals for the passage
of nervous filaments. On the inner wall o
vestibule, a little in front of the orifice com
to the two vertical semicircular canals
within the limits of the posterior horn, ther
bordering on the hemi-elliptical and hemis
rical depressions, below the former and be
the latter, another very small depressio
sulcus, *fossa s. cavitas sulciformis*, which
upwards and backwards to a small obl
orifice, that of the aqueduct of the vesti
osteum internum aqueductus vestibuli. At
middle of the inner wall of the vestibule, w
the boundary lines of these three depress
meet, there is a slight eminence.

The inner wall of the vestibule corresp
to the bottom of the internal auditory mea
and is pervaded by small canals, some of w
have been already mentioned, for the pas
of fibrils of the auditory nerve and of b
vessels.

In the outer wall of the vestibule there
oval, or rather a kidney or bean-shaped
called *foramen ovale, s. fenestra ovalis, s. f*
tra vestibuli. The long diameter of this
ture, which is about one-tenth of an in
perhaps a little more, is directed from b
forwards. Its vertical diameter is about
that of its long diameter. The upper p
the circumference of the hole is arched
wards, the lower part is slightly inclined i
same direction. The margin of the vesti
fenestra is turned in towards the vest
Viewed from the tympanum, into wh
opens in the macerated bone, the vest
fenestra appears situated at the bottom
fossa, which was called by Cotugno
ovalis. In the recent state the vestibular
stra is closed in by the base of the stapes.

The semicircular canals, (canales semi
lares; Fr. *les canaux semicirculaires;* Ger
Bogengänge oder halbcirkelförmigen Ca
These are three canals, which, describing
than the half of an irregular circle, open a
of their extremities into the vestibule;
if it was not for the circumstance tha
unite by one of their extremities to f
common short canal, there would be i
vestibule six orifices of semicircular cana
stead of the five only which exist. The
of these canals is about one-twentieth of a
in the direction from the concavity to th
vexity of their curve; in the opposite di
they are somewhat compressed, so that a
verse section, instead of presenting a
orifice, presents an elliptical one. The s
cular canals are wider where they open i
vestibule, but especially so at one of th
tremities, which presents a dilatation
form of a bulb, called ampulla or am
sinus, *sinus ampullaceus*.

Two of the semicircular canals oc
vertical position and one of them a hor

vertical, one is *anterior* and *superior*,
r *posterior* and *inferior*. The *horizon-*
ternal.
ior vertical semicircular canal, canalis
ularis verticalis superior. The superior
semicircular canal has its arch directed
s, and its extremities, which are more
divergent than those of either of the
o semicircular canals, downwards. Fol-
om its outer extremity, it describes its
om without and upwards, then down-
nd inwards, with an inclination from
ackwards,—in a word, across the petrous
The convexity of the curve of this semi-
canal can always be recognized on the
urface of the petrous bone. The con-
f it is free in the fœtus and in the adult
: of the lower animals, as the dog, hare,

inner extremity of the superior vertical
cular canal and the upper extremity of
terior vertical unite to form a common
canalis communis, which is about one-
of an inch long, and somewhat wider
her of the two which unite to form it.
erior vertical semicircular canal, canalis
cularis verticalis posterior. Leaving the
n canal, the posterior vertical semicircu-
al describes its curve parallel to the
nd posterior surface of the petrous bone,
dicularly from above backwards, then
ards and forwards. The convexity of
rve is thus directed backwards and
outwards, its extremities forwards and
s.
izontal semicircular canal, canalis semi-
ris horizontalis. This is the shortest of
ee canals; traced from its anterior extre-
which is close to that of the superior ver-
t curves outwards and backwards, then
s and forwards. Its convexity is out-
its extremities directed inwards.
described in the vestibule three horns,
he posterior and into the superior of
the semicircular canals opened. In the
or horn is observed the orifice of the ex-
extremity of the superior vertical semi-
r canal, and immediately below that and
the fenestra vestibuli, the orifice of the
or extremity of the horizontal semicircular
Both of these orifices are dilated into
llæ. In the posterior horn is the orifice
canal common to the two vertical semi-
ar canals. Below and in front of this
is the opening of the inferior extremity
e posterior vertical semicircular canal.
e the latter and immediately outside the
r is the opening of the posterior extremity
e horizontal. Of all these orifices in the
rior horn, that of the lower extremity of
osterior vertical semicircular canal is the
one which is dilated into an ampulla.
here are thus three ampullary dilatations,
at the outer extremity of the superior verti-
emicircular canal, a second at the anterior
mity of the horizontal, and the third at the
r extremity of the posterior vertical. In
ower and anterior wall of the ampullary
s of the posterior vertical semicircular canal is a small sieve-like spot indicating the entrance of nervous filaments.

The cochlea, (cochlea; Fr. le limaçon; Germ. die Schnecke.)—The cochlea does not exist in all its perfection except in the Mammifera. In birds it is in a very rudimentary state, but it is easy to trace parts analogous to what we find in the Mammifera. In regard to frequency of occurrence in the animal series, the cochlea does not stand next to the semicircular canals; the tympanum is found in a greater number of animals.

The cochlea forms the anterior part of the labyrinth, and is, perhaps of all the parts of the ear, that of which it is the most difficult to give, either by descriptions or delineations, a correct idea. If we can figure to ourselves a tube tapering towards one extremity where it ends in a cul-de-sac, and coiled, like the shell of a snail, round an axis or central pillar; and if we suppose this tube subdivided into two passages by a thin partition running throughout its length, and of course spirally round the axis, we shall have some conception of the disposition of the cochlea.

The tube of which the cochlea is composed, *canalis spiralis cochleæ*, is about an inch and a half long, about one-tenth of an inch in diameter at its commencement, and about one-twentieth of an inch at its termination. It describes two turns and a half, and that in a direction from below upwards—from left to right in the right ear, and from right to left in the left ear. The apex of the coil, which is also the apex of the tube itself, is directed forwards and outwards. The commencement of the first turn of the cochlea forms an eminence towards the cavity of the tympanum, called the *promontory*. The second turn lies at its commencement within the first, and only towards its termination rises decidedly above the level of it. By the base of the tube the cochlea is connected with the vestibule. The cul-de-sac at the apex forms a sort of vaulted roof called *cupola*.

The axis, or central pillar, modiolus s. columella cochleæ. The first turn of the cochlea takes a wider circular sweep than the rest, a sweep having an average diameter of a quarter of an inch, and is separated from the second turn by the interposition of a soft bony substance, which extends also a little way between the second and third. The axis, or central pillar, as has been pointed out by Ilg,* is nothing more than the internal walls of the tube of the cochlea and the central space circumscribed by their turns, in which space the filaments of the cochlear nerve, running in small bony canals, are contained. Now in consequence of the wide sweep the first turn of the cochlea takes in comparison with the rest, the axis is very thick, about one-seventh of an inch, where it is surrounded by the first turn, and rapidly becomes thinner from the second onwards to its termination. The last part o it is in fact formed merely by the fold whic the internal wall of the tube of the cochlea necessarily forms where it bends abruptly at the last turn. This last part of the axis, viewed from the cavity of the second turn of the tube, has a funnel-like appearance, the wide mouth corresponding to the cupola; hence it is called *infundibulum* or *scyphus*. But viewed from the last turn, the so-called infundibulum is a mere free edge which proceeds directly to be confounded with the walls of the cochlea. But all this, if the disposition of a snail's shell, or a tube coiled round be rightly conceived, is understood of itself.

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* Einige anatomische Beobachtungen, etc Prag. 1821, p. 7.

Exposed by the removal of the outer walls of the cochlea, the axis is somewhat like the common pictorial representations of the tower of Babel. It has a spongy porous appearance. It is pervaded by numerous small canals which run from its base onwards to orifices on its sides, corresponding to the spiral lamina, and transmit into the cochlea the ramifications of the cochlear branch of the auditory nerve and bloodvessels. The outermost of the canals are the shortest; towards the interior they gradually become longer, and there is one canal in particular wider than the rest, which runs throughout its whole length; it is called *tubulus centralis modioli*, and opens at the so-called infundibulum.

The base of the axis corresponds to the anterior part of the inferior depression at the bottom of the internal auditory meatus, and presents the commencing orifices of the small canals just mentioned, arranged in a spiral manner corresponding to the turns of the cochlea, *tractus spiralis foraminulentus* of Cotugno.[*]

Spiral lamina and scalæ of the cochlea.—The passages into which the tube of the cochlea is subdivided are called *scalæ*, and the partition *lamina spiralis*.

The spiral lamina is partly bony, partly membraneous; but as we are describing the osseous shell of the labyrinth only, it is with the bony part alone we have at present to do. The bony part of the spiral lamina, *zonula ossea laminæ spiralis*, is coiled round the axis or central pillar of the cochlea like the stairs in a spiral staircase. The internal or central margin of the bony spiral lamina is inserted on the axis. Its peripheral margin is free in the dry bone, so that the two scalæ are not found completely separated from each other, as in the recent state, when the membraneous extension of the spiral lamina exists. At the place where the spiral lamina is inserted on the axis, there is a sort of canal all round, which has been specially described by Rosenthal[†] under the name of *canalis spiralis modioli*.

The spiral lamina commences with a bend or sweep upwards and forwards at the base of the cochlea, below the hemispherical depression of the vestibule and opposite the bridge of bone which separates the vestibular fenestra
from the cochlear fenestra. Its broadest part
which is about the middle of the first turn o
the cochlea, is about one-twentieth of an inch
Towards the summit of the cochlea it insen
sibly contracts, and ceasing to be connect
to the axis, where the latter presents the f
margin already mentioned, terminates at
commencement of the third turn in a cur
hook-like point. This hook, *hamulus lam*
spiralis, has a free concave margin towards
axis, and a convex margin, which latter, h
ever, like the rest of the peripheral margin
the bony spiral lamina, is not free in the re
state, but is continuous with the membr
which completes the partition.

In consequence of the above mode of te
nation of the bony spiral lamina by means
a free margin towards the axis of the cochl
an opening of communication is left, even
the recent state, between the two scalæ of t
cochlea. For this opening, which was cal
by Cassebohm[*] *canalis scalarum communis*,
adopt from Breschet[†] the name *helicotrema*

The bony spiral lamina consists of two t
plates of bone, between which run numer
small canals from the central margin of
lamina to its peripheral—the continuation
those already described in the axis, and wh
therefore bend at a right angle in passing fr
the axis into the spiral lamina. At the f
edge of the osseous part of the spiral lami
the two plates of bone are intimately incor
rated. This part of the bony spiral lam
which is more delicate, denser, whiter, m
transparent, and, in the recent state, m
elastic than the rest, is what Breschet calls
middle zone. The surface of the spiral lam
corresponding to the tympanic scala is m
marked with striæ running from the in
margin to the outer. The surface correspo
ing to the vestibular scala is less striated.

Of the two scalæ of the cochlea, one, *s*
tympani, communicates with the cavity of
tympanum through the fenestra rotunda
cochlear fenestra, which however, in the re
state, is closed by a membrane; the ot
scala vestibuli, opens by an oval orifice fr
into the vestibule, and it is only by mean
the communication which the tympanic s
has with the vestibular scala through the h
cotrema that the former communicates with
rest of the labyrinthic cavity. The tym
scala is wider at the commencement than
vestibular, which on its part again is la
toward the termination. Near the fenestr
tunda there is in the tympanic scala a
minute orifice, that of the aqueduct of
cochlea. We shall return to the spiral lan
the scalæ of the cochlea, and the mechanis
the helicotrema, when speaking of the m
brane lining the labyrinthic cavity.

The aqueducts.—What are called the a
ducts are two canals of very minute ca
opening by one extremity in the labyri

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[*] De aqueductibus auris humanæ internæ anatomica dissertatio, s. xxiv. pp. 36—38. Viennæ, 1774.

[†] Ueber den Bau der Spindel im menschlichen Ohr. In Meckel's Archiv. Bd. viii. p. 75.

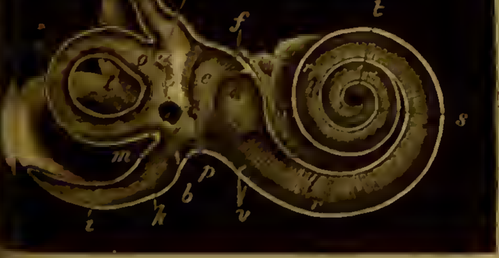
[*] Tractatus quintus anat. de aure humana
Halæ Magd. 1735, s. 194, p. 12.

[†] Op. cit. s. xiv.

[‡] [illegible]

ınd by the other on the surface of the
portion of the temporal bone. They
rally associated with the name of Co-
who, though not their discoverer, was
to give a complete description of them.
lled *aquæductus vestibuli*, communicates
vestibule; the other, *aqueductus coch-*
ı the tympanic scala of the cochlea.
nternal orifice of the aqueduct of the
e is observed to commence by a groove
s, the *sulciform depression* already de-
in the vestibule, immediately below
ront of the opening common to the two
semicircular canals. From this the
t turns itself round the inner wall of
mon canal, and then follows a course
rds and backwards. Gradually widen-
pens under that sort of osseous scale
l a little behind the middle of the pos-
nd inner surface of the petrous bone,
ve the jugular fossa; towards the latter
usually a groove running on the surface
bone from the orifice of the aqueduct.
gth of the course of the aqueduct of
ibule is about one-third of an inch.
queduct of the cochlea commences by
small orifice in the lower wall of the
mpani immediately before the fenestra
. It proceeds downwards, inwards,
wards, in the inner wall of the jugular
f the temporal bone, and widening in
se it opens at the bottom of that tri-
pyramidal depression, situated towards
ldle of the edge which limits the inner
erior surfaces of the petrous bone, and
the internal auditory meatus. The
f its course is about a quarter of an inch.
ueduct of the cochlea is very wide in
Of the aqueducts we shall observe
in speaking of the membrane lining
rinthic cavity.

Fig. 2.



byrinthic cavity of the right side, magnified two diameters.

uperior horn of the vestibule; *b*. posterior ferior horn; *c*. anterior and inferior horn into the cochlea; *d*. hemispherical depres- *e*. hemi-elliptical depression; *f*. pyramidal ion between the two having a porous sieve- pearance from being pervaded by canals for assage of nervous filaments; *g*. superior l semicircular canal; *h*. its ampullary dila- ; *i*. posterior vertical semicircular canal; ampullary dilatation; *l*. canal common to the superior and posterior vertical semicircular canals; *m*. orifice by which the common canal opens into the vestibule; *n*. horizontal semicircular canal; *o*. its ampullary dilatation; *p*. vestibular orifice of the aqueduct of the vestibule; *q*. osseous part of the spiral lamina, seen from the surface which corresponds to the vestibular scala; *r r*. space which is occupied by the membraneous part of the spiral lamina; *s*. hamulus or hook in which the bony spiral lamina ends; *t*. helicotrema; *u*. substance of the petrous bone, between the first turns of the cochlea; *v*. orifice of the aqueductus cochleæ.

Membrane lining the labyrinthic cavity.—The cavities of the osseous labyrinth which we have just described are lined by a serous or fibro-serous membrane, extremely delicate and closely adherent to the surfaces. *The membraneous labyrinth must not be confounded with it.* This membrane, which may be compared to that serous pellicle on the inner surface of the sclerotica, known by the name of membrana fusca or arachnoidea oculi, is more manifest at an early age than in adults, and is nowhere so distinct as at the places where the nerves enter, and at the bottom of the tympanic scala of the cochlea. It is it which completes the spiral septum of the cochlea, by an arrangement immediately to be described.

The fenestra rotunda or cochlear fenestra is, in the recent state, closed by a membrane which shuts out the cavity of the tympanum from any direct communication with the cochlea. This membrane, called by Scarpa* the secondary membrane of the tympanum, *membrana tympani secundaria*, is concave towards the cavity of the tympanum, convex towards the tympanic scala of the cochlea, and is received at its circumference into a groove within the orifice of the fenestra rotunda. It is composed theoretically of three layers, the inner of which is nothing but the fibro-serous membrane under consideration. The outer layer is a continuation of that which lines the cavity of the tympanum. The third and proper layer is situated between the two mentioned. The same may be said in regard to that membrane, which, together with the base of the stapes, closes the vestibular fenestra.

The membrane lining the tympanic scala of the cochlea is continued into that lining the vestibular scala at the opening called helicotrema. The membrane of the vestibular scala is continuous with that lining the vestibule, which on its part is continuous with that of the semicircular canals. Lastly, the same membrane lines the aqueducts.

Such is a general description of the membrane lining the labyrinthic cavity; but to understand the disposition of the cochlea and aqueducts in the recent state, we must take a nearer view of this membrane such as it exists in those cavities, which, indeed, is the most important and difficult part of it.

Of the cochlea in the recent state.—The cochlea is the last addition made to the labyrinth in the ascending scale of the animal series. As was said, it is in birds in a very rudimentary state. It is in fact a mere pouch or diverticulum not at all coiled up, in which, however, can be distinguished a part corresponding to a lamina spiralis, which is represented by a cartilage, and a vestibular and a tympanic scala, together with a cochlear fenestra. This analogy, much insisted on by Breschet,[*] I gave a brief notice of some years ago.[†]

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* Op. cit.

* De auditu et olfactu. cap. ii. s. 19. p. 35.

The cochlea is richly supplied with nerves. The spiral lamina is that part of it on which its nerves expand; this must therefore be considered as forming a very essential element of the cochlea, and may be viewed as being in the economy of that part of the internal ear what the apparatus of the membraneous labyrinth is to the vestibule and semicircular canals.

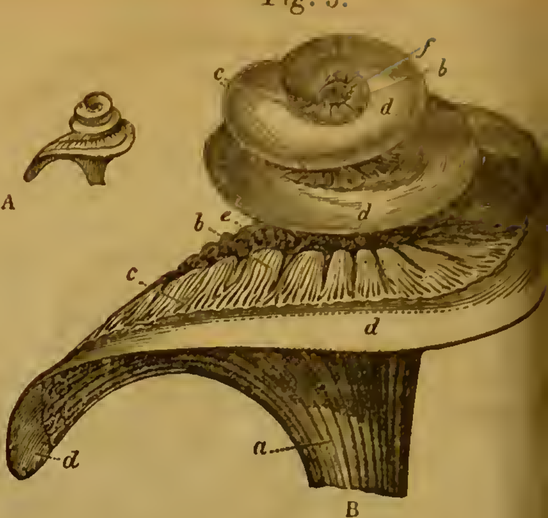
The bony spiral lamina is rendered a complete partition between the scalæ of the cochlea by a membraneous continuation, *zonula membranacea laminæ spiralis s. zona Valsalvæ*, formed by the application against each other of the membranes, which line the interior of the two scalæ, at the moment they are reflected from the free edge of the bony spiral lamina to the outer walls of the cochlea. Hence the spiral partition of the cochlea, when complete, is osseous at its inner or central part, and membraneous at its outer or peripheral.

The outer part of the osseous zone of the spiral lamina is thinner than the rest; it is semi-osseous, semi-membraneous, and the membraneous spiral lamina at its junction with it presents a fine cartilaginous stripe; hence Comparetti and Sömmerring described the spiral lamina as composed of concentric bands or zones. They admitted four, viz. 1, the inner thick part of the bony spiral lamina; 2, the outer thin part; 3, the cartilaginous stripe commencing the membraneous spiral lamina; and 4, the rest of the membraneous spiral lamina, or the membraneous spiral lamina properly so called. The first zone is continued into the hamulus cochleæ, the second ceases towards the second turn of the cochlea, and the third and fourth are continued beyond the hamulus cochleæ, forming of themselves the spiral partition in the last turn.

It is sufficient to admit, with Breschet,[‡] only three zones; an osseous zone, a middle zone, and a membraneous zone; the third and fourth zones of Comparetti being comprehended under the latter.

The osseous zone of the spiral lamina we have already described, and alluded to the middle zone. The latter, when it still exists in the dry bone, appears merely as the outer margin of the former. It is the narrowest of the three zones, and is most distinct in the first turn of the cochlea. Breschet describes composed of the membranes lining the int of the two scalæ, where they first meet other in passing from the bony spiral lan together with osseous particles deposited tween them. In this interstice between membranes also are contained the last r fications of the filaments of the cochlear n still enveloped by their neurilemma, sprinkled over by the small bony particle mentioned.

Fig. 3.



The axis of the cochlea and spiral lamina isola in order to show the disposition of the three z The vestibular lamina of the osseous zone i moved. (From Breschet.)

A, natural size. B, magnified.

a. trunk of the cochlear nerve; *b.* distributi the filaments of this nerve in the osseous zo *c.* nervous anastomoses in the middle zone membraneous zone; *e.* osseous substance of axis; *f.* helicotrema or hole of communica betwixt the two scalæ.

Different from the middle zone, the m braneous zone goes on increasing in bre though not regularly, from the base t summit of the cochlea. It is the longes most extensive of the three zones. It alone which extends into the last turn c cochlea. According to Breschet the braneous zone should be composed of layers, the two exterior of which shoul as already said, formed by the meml lining the interior of the scalæ, and the dle one by the expansion and interlacing neurilemmatic sheaths from the middle but these layers are so thin and so c united that they are inseparable, and con a membrane of great thinness and transpa on which, however, bloodvessels can be seen.

The membraneous zone presents a margin continuous with the rest of the lamina, except in the third turn of the co where this margin forms nearly the tl the circumference of the helicotrema where it runs into the peripheral margin acute angle. The peripheral margin, is much thicker than the rest of the braneous zone, is pervaded by a vascular like that which in the eye runs rou circumference of the cornea at the inser the iris.

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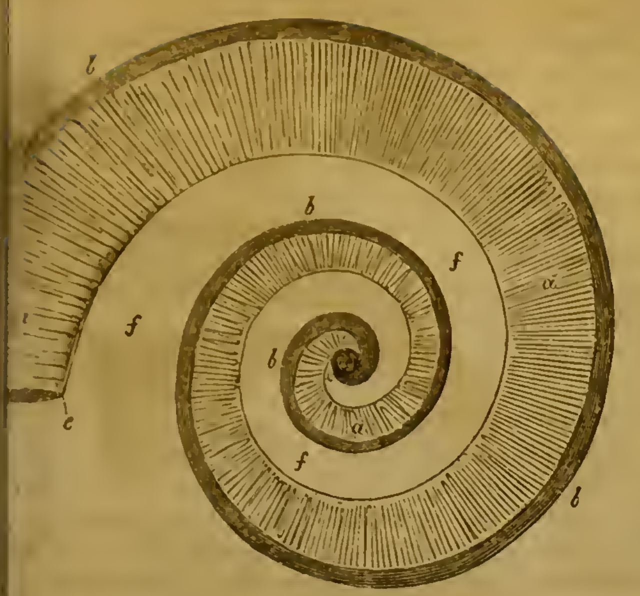
[*] Op. cit. and also Recherches Anatomiques et Physiologiques sur l'organe de l'audition chez les Oiseaux. Paris, 1836.

[†] "Note on the ear of Birds," in the first and only volume of the second series of the Edinburgh Journal of Natural and Geographical Science. Edinburgh, 1831.

[‡] Op. cit. chap. ix. s. cxcix.

Fig. 4.

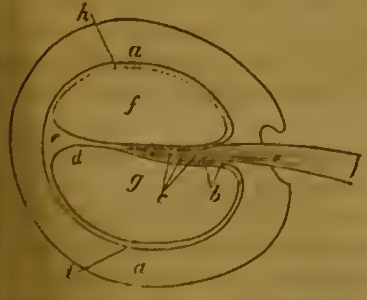


ı from Breschet, intended, according to him, to give an
lea of the disposition of the helicotrema. The walls
estibular scala are supposed to be removed.

represent the osseous and middle zone of the spiral
ts termination in the hamulus or hook is seen;
is darker and narrower stripe represents the mem-
zone of the spiral septum; towards the summit of
a it becomes a little broader, and at its termination
s by itself alone the septum between the two scalæ
rmination; c. the commencement of the tympanic
the external or great margin; *e.* the internal mar-
ıe turns of the cochlea; the two margins *d* and *e*
; *f f f.* the vacant space corresponding to the axis;
ıtes at *o*, which corresponds to the summit of the
ıelicotrema or hole which establishes a communica-
en the two scalæ.

ction of the peripheral margin of the
ıeous zone presents a triangular sur-
base of which is inserted on the osse-
of the cochlea. This swollen margin
nembraneous zone is, according to
evidently continuous, at the origin
iral lamina in the base of the cochlea,
osseous zone, a circumstance which
ularly to be remarked in very young
where all these parts are still cartila-
This thickened margin of the mem-
zone Breschet therefore considers as
s to the tympanic cartilage of the
chlea, having exactly the same rela-
l uses.

Fig. 5.



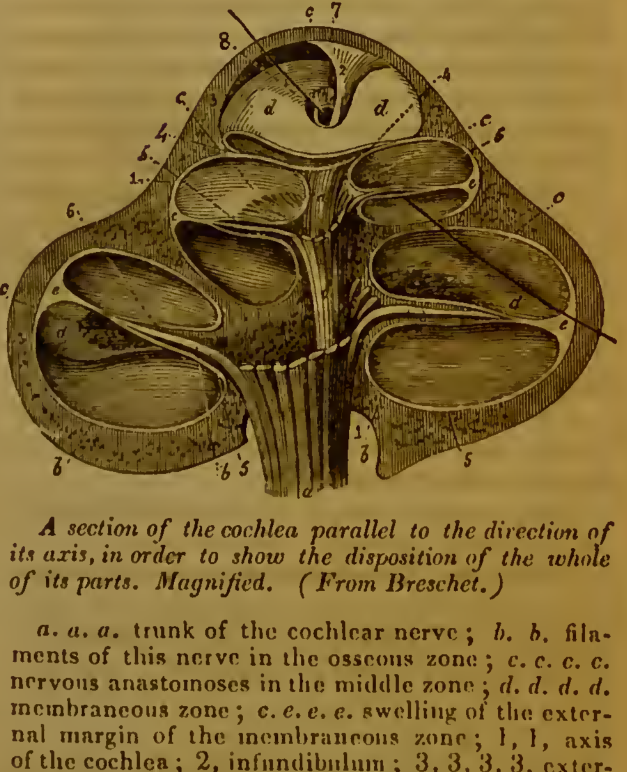
of a transverse section of the two scalæ of the cochlea (from Breschet).

sseous wall; *b.* osseous zone compared to
bular cartilage of the cochlea of birds; *c.*
zone compared to the auditive lamellæ;
raneous zone; *e.* cartilaginiform swelling of
nal margin of the membraneous zone, compared to the tympanic cartilage of birds; *f.* scala vestibuli; *g.* scala tympani; *h.* periosteum lining the vestibular scala, more vascular than fibrous; *i.* periosteum of the tympanic scala; *j.* nerve.

In vascularity and richness in nerves, the spiral lamina bears a great resemblance to the iris. Like it, also, it is the partition between two chambers, containing an aqueous humour, and communicating, like the aqueous chambers of the eye, by a single orifice.

The two scalæ of the cochlea have not the same length nor the same diameter. Toward the base of the cochlea the tympanic scala exceeds somewhat the vestibular; its diameter is, at the same time, also a little more considerable, as far as towards the middle of the first turn of the spire. The two scalæ have then the same diameter, and preserve the equality to the commencement of the last turn. There the tympanic scala contracts, and in particular flattens considerably, and is at last confounded, through the helicotrema, with the vestibular scala, which still continues for two-thirds of a turn, and then ends in a cul-de-sac. This is also to be noted in regard to the vestibular scala of the bird's cochlea, which indeed is very large, and proceeds considerably beyond the tympanic scala. It ends in a large cul-de-sac called *lagena*.

Fig. 6.



A section of the cochlea parallel to the direction of its axis, in order to show the disposition of the whole of its parts. Magnified. (From Breschet.)

a. a. a. trunk of the cochlear nerve; *b. b.* filaments of this nerve in the osseous zone; *c. c. c. c.* nervous anastomoses in the middle zone; *d. d. d. d.* membraneous zone; *e. e. e. e.* swelling of the external margin of the membraneous zone; 1, 1, axis of the cochlea; 2, infundibulum; 3, 3, 3, 3, external osseous wall of the cochlea; 4, 4, 4, 4, osseous lamina separating the turns of the spire of the cavity of the cochlea; 5, 5, 5, 5, tympanic lamella of the osseous zone of the spiral lamina; 6, vestibular lamella; 7, hamulus or hook, which terminates the osseous zone; 8, helicotrema, with a bristle introduced into it.

Farther observations on the aqueducts.—The aqueducts, the one leading from the vestibule, and the other from the tympanic scala of the cochlea, are lined by a continuation of the thin and delicate pellicle which invests the interior of those cavities.

Under the osseous scale, on the surface of the petrous bone, where the aqueduct of the vestibule ends, there is a small triangular pouch produced by a separation of the dura mater into two layers. Into this pouch the lining membrane of the aqueduct enters, and ends in a cul-de-sac. The pouch is called by Cotugno the *membraneous cavity of the aqueduct.* I found the structure just described of unusual size, in consequence of irregular development, in the ear of a man deaf and dumb from birth, which I examined some years ago. The triangular pouch in the dura mater was about one-third of an inch long at its sides, and was distended by a clear liquid. Every time pressure was made on the distended pouch, a fine jet of liquid issued through a small opening which had been made in the superior vertical semicircular canal. Similar cases have been described by Mondini[*] and others.

The lining membrane of the aqueduct of the cochlea ends, in like manner, in a cul-de-sac, which, however, is not so large as that of the aqueduct of the vestibule.

The liquid contained in the labyrinthic cavity, or liquid of Cotugno, or perilymph. (Aquula Cotunnii.)—The cavities of the osseous labyrinth contain a liquid, the secretion, probably, of their thin and delicate lining membrane. *They contain no air, as has been asserted.* The liquid called the liquid of Cotugno, or by De Blainville *perilymph*, must not be confounded with another which is contained in the interior of the *membraneous labyrinth.* Dominico Cotugno,[†] though not actually the discoverer of this liquid, yet took a more correct view of it than his predecessors in this branch of anatomical research, Valsalva,[‡] Vieussens,[§] Cassebohm,[||] and Morgagni.[¶] He in fact recognised in it a substance fulfilling some office in the exercise of hearing, a view of the matter which was admitted by Haller, and put beyond doubt by Ph. Fr. Meckel,[**] and since their time recognised by all physiologists.

The perilymph occupies, in the vestibule and semicircular canals, all the space not taken up by the membraneous labyrinth. The cochlea contains nothing but it; and as all the cavities of the osseous labyrinth communicate, it the same humour in each.

In all fishes, except the cartilaginous with fix gills, the labyrinthic cavity is very imperf being in many of them open towards the cr cavity, or at the most separated from it only a membraneous partition, as in the cod; the encephalic liquid in some of them is no tinct from the perilymph whose function it perform. In the cartilaginous fishes with gills, on the contrary, the labyrinthic cav completely separated from the cranial; the in them we meet with perilymph distinct the encephalic liquid, and that, too, in large quantity.

In birds the perilymph is in much less q tity than in the mammifera, in proportion to size of the membraneous labyrinth. In tiles the quantity of perilymph is still less.

Cotugno and Meckel supposed that aqueducts were a sort of diverticula, or ties which served to let off the superabu perilymph, when necessary, during the ac hearing. This opinion is, however, now-a very much questioned, and several anato Brugnone, Ribes, Breschet, &c., refuse to aqueducts the uses which Cotugno assi them, and consider them merely as canals tined for the passage of bloodvessels. Altho they may be insignificant in a physiol point of view, still, if the description I given of them be correct, they must be dered as something more than mere canal the transmission of vessels. The constan the aqueducts, moreover, is another argu against their being mere vascular canals.

Breschet,[*] and in Hildebrandt's *Anatom* Weber[†] the same idea is concisely expre explains the mode of formation of the ducts by supposing that at first the labyr cavity is nothing but a sac formed by a pr gation of the dura mater in the same way tunica vaginalis is of the peritoneum; th development proceeds, the tube of com cation between the labyrinthic sac of the mater and general cavity of the dura ma gradually contracted and elongated; and ossification extends, the tube becomes rounded by osseous substance, and pr itself under the appearance of an aqu

"This view," says Breschet, "is re probable, for in many fishes the laby cavity forms one with that of the cr and if, in these animals, a prolongation walls of the cranium tended to separa brain from the ear, there would result a canal establishing a communication b the two cavities, and this canal wou nothing but an aqueduct."

According to this view, the lining me of the labyrinthic cavity may be consid a continuation of the arachnoideal laye dura mater, perhaps of the dura mater a

2. *The membraneous labyrinth, (laby membranaceus.* Fr. *Labyrinthe memb* Germ. *Das häutige Labyrinth.)*—Wit

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[*] Comment. Bonon. tom. vii. Anatomia Surdi Nati. p. 422.

[†] De Aqueductibus Auris Humanæ Anatomica Dissertatio, s. xxix.-xxxi. Neapoli, 1760.

[‡] De Aure Humana Tractatus, &c., cap. iii. s. 17, p. 79. Trajecti ad Rhenum, 1707.

[§] Traité Nouveau de la Structure de l'oreille, p. 75. Toulouse, 1714.

[||] Tractatus Quintus Anatomicus de Aure Humana, &c., pp. 20-21. De Labyrintho. Halæ Magd. 1735.

[¶] Epist. Anatom. xii. s. 64, p. 469. Venetiis 1740.

[**] Dissertatio Anatomico-Physiologica de Labyrinthi Auris Contentis, &c. Argentorati, 1777, s. 8.

[*] Op. cit.

[†] Band iv. p. 32.

labyrinth is contained an extremely and complicated membrano-ner- pparatus, called *membraneous laby-* first properly described by Scarpa.* not extend into all the compartments sseous labyrinth, but only occupies the e and semicircular canals. The coch- has been said, contains in its cavity but perilymph.

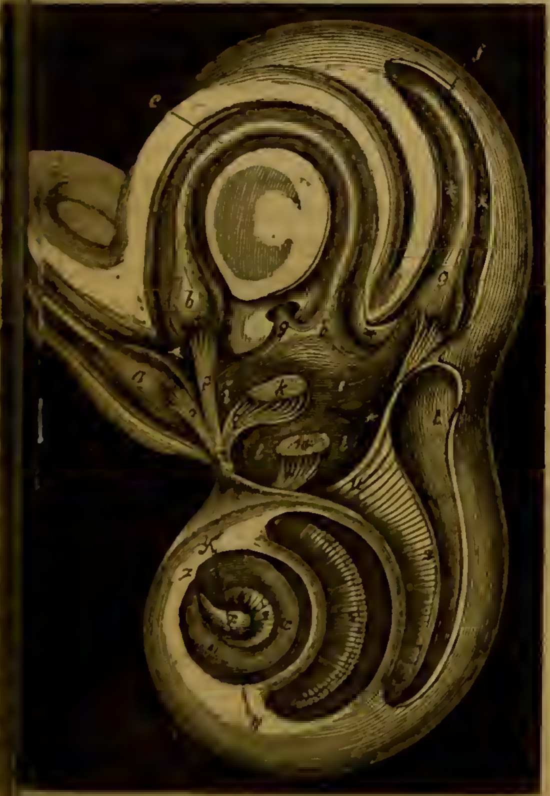
vestibular part of the membraneous h, and of that perhaps one of the ; only, is all that is really fundamental structure of an organ of hearing. In stacea and Cephalopodous Mollusca in the organ of hearing exists in its sim- rm, and even in the Cyclostomatous here is nothing but a small pouch con- a little liquid and a lapilliform body.

h smaller than the cavities which con- the membraneous labyrinth is sus- as it were in the perilymph. It does ear to adhere to the walls of the laby- cavity except at the points where it re- ervous filaments.

component parts of the membraneous th are:—

he common sinus. 2. The membrane- pullæ and semicircular tubes. 3. The .

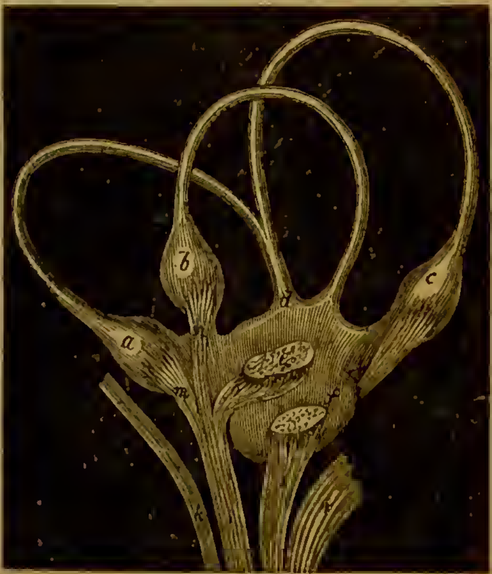
Fig. 7.



gnified representation of the left osseous laby- h laid open to show the membraneous labyrinth 's situation. (From Breschet.)

nembraneous ampulla of the ampullary sinus e anterior semicircular canal; *b.* membrane- mpulla of the ampullary sinus of the external ircular canal; *c.* membraneous ampulla of mpullary sinus of the posterior semicircular ; *d.* anterior membraneous semicircular tube; ternal membraneous semicircular tube; *f.* rior membraneous semicircular tube; *g.* common membraneous tube resulting from the junction of the tubes *d* and *f*; *h.* the place where the external membraneous semicircular tube opens into the common sinus; *i i.* common sinus filling a great part of the vestibule; *k.* a small mass of calcareous powder shining through its walls; *l l.* saccule, also containing, *m.* another mass of calcareous powder; *n* a nervous fasciculus, furnishing, *o.* an expansion to the anterior membraneous ampulla; *p.* another to the ampulla of the external tube, and *q.* a third to the common sinus; *r.* nervous fasciculus to the saccule; another fasciculus of nervous filaments, not lettered, is seen going to the ampulla of the posterior membraneous semicircular tube; *s s.* spiral lamina; *s'.* the termination of the spiral lamina in the hamulus; *t.* commencement of the scala tympani near the fenestra rotunda, which is here no longer seen; *u.* commencement of the scala vestibuli; *x.* extremity of the axis around which the termination of the spiral lamina turns; *y y.* a bristle engaged in the helicotrema; *z.* place where the summit of the axis is continued into the wall of the osseous labyrinth; *w w w,* membraneous portion of the spiral lamina, particularly broad in the last turn, (lettered *u u u* in the figure instead of *w w w*); * * * * * * spaces between the walls of the labyrinthic cavity and membraneous labyrinth occupied by the perilymph.

Fig. 8.



The left membraneous labyrinth isolated together with the nerves. Magnified. (From Breschet.)

a. ampulla of the anterior semicircular tube; *b.* ampulla of the horizontal semicircular tube; *c.* ampulla of the posterior semicircular tube; *d.* common tube; *e.* mass of calcareous particles lying in the common sinus; *f.* the saccule containing also a mass of calcareous particles; *k.* portio dura of the seventh pair; *m.* nervous filaments to the ampulla of the anterior semicircular tube; *n.* filaments to the ampulla of the horizontal semicircular tube; filaments are also seen going to the ampulla of the posterior semicircular tube, not lettered; *o.* filaments to the common sinus; *q.* filaments to the saccule; *r.* cochlear nerve.

The common sinus, membraneous ampullæ, and membraneous semicircular tubes.—These constitute but one apparatus which is just the counterpart of the vestibule, ampullary sinuses and semicircular canals of the osseous labyrinth; the semicircular tubes opening into the ampullæ and common sinus in the same wa that the semicircular canals open into the ampullary dilatations and the vestibule.

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* De auditu et olfactu.

The common sinus is an elongated, laterally compressed pouch, and lies in the posterior part of the vestibule. It extends into the upper horn to join the ampullæ of the superior vertical, and of the horizontal semicircular tubes; and into the posterior and lower horn, to join the ampulla of the posterior semicircular tube, and to receive the tubulus communis and cylindrical extremity of the horizontal tube, as they emerge from their respective canals. Its upper end, which is larger than its lower, lies in the hemi-elliptical cavity, to the bottom of which it is fixed by nervous filaments.

The membraneous tubes are only about a third part of the calibre of the semicircular canals in which they are contained. Like the latter they are distinguished by the epithets, superior vertical, posterior vertical, and horizontal. Each membraneous semicircular tube opens at one of its extremities, like its corresponding osseous canal, into an oval dilatation called *ampulla*, which on its part communicates with the common sinus. As the vertical semicircular canals unite at one of their extremities to form the common canal, so their corresponding membraneous tubes also unite to form a common tube, *tubulus communis*, which occupies the common canal.

At the place where the nervous filaments enter the common sinus, its wall presents a much more considerable thickness and consistence than elsewhere.

According to Steifensand,[*] who has examined the structure of the ampullæ very carefully, each ampulla presents a very much arched surface, *superficies convexa*, and opposite to this a concave or indented surface, *superficies concava s. inflexa*, which receives the nervous filaments. Where the nerve enters there is a transverse depression, *sulcus transversus*, by which this surface is divided into two parts. This transverse depression on the outside produces in the interior a fold of the membrane composing the wall of the ampulla, and through which the nerve enters. This fold forms a transverse septum, *septum transversum*, which divides the interior of the ampulla into two parts; one of which, the sinus part, communicates by the *osteum sinus* with the common sinus, and the other, the tube part, by the *osteum tubuli* with the membraneous tube.

Saccule, sacculus rotundus. This is a round membraneous bag, smaller than the common sinus in front of which it lies in the hemispherical depression of the vestibule. It is firmly fixed in its place by nervous filaments which proceed to it through the apertures observed in the bottom of the hemispherical depression. As has been mentioned in regard to the common sinus, the wall of the saccule presents an increase of thickness and consistence at the place where the nervous filaments enter it.

Small in the Mammifera, the saccule is ver distinct and large in fishes.

The common sinus and saccule adhere t each other, but whether their cavities co municate has not been determined. They a fixed, as has been said, to the inner wall of th vestibule, by the nervous filaments which th receive through the apertures with which part is perforated. Towards the outer w they are nowhere in contact with the base the stapes, the perilymph intervening. T circumstance, first distinctly pointed out Scarpa,[*] and particularly insisted on by B schet, shows that it is only by the intermed of the perilymph that the movements of stapes can have any impression on the nerv expansions of the membraneous labyrinth.

The common sinus, ampullæ, semicirc tubes, and saccule are composed of a firm tra parent membraneous coat, within which is a n vous expansion, and outside which is a cell vascular layer, in some places tinged black brown. Of the nervous expansion we sha speak under the head of the auditory nerv In the sheep, hare, rabbit, &c. the walls the membraneous labyrinth present patches black pigment, a circumstance noticed Scarpa,[†] Comparetti,[‡] and Breschet.[§] Bef I knew of the observations of these anatomi I had myself observed the fact. I was n however, led to the discovery of it by accide but, being engaged in researches on the p ment of the eye, and considering the analo which the organs of sense bear to each oth in their general anatomical structure, I w curious to know whether pigment did not ex also in the ear. Examination proved to m that it did; for I found, as Scarpa and Co paretti had previously noticed, pigment d posited in the form of small black spots in t membraneous parts of the labyrinth in d ferent Mammifera. In some I have found distinct cellulo-vascular layer of a black brown colour forming the outer surface of membraneous labyrinth. And, contrary what Breschet asserts, I have found pigm in the membraneous labyrinth of the hum ear also. It appears, especially on the a pullæ, under the form of a slight but perfec distinct brown tinge, similar to what is se around the ciliary processes in the eyes Albinos.

Semicircular tubes are found in all the V tebrate animals, with the single exception the Cyclostomata. When they do exist th are never more nor less than three.

The common sinus, ampullæ, semicircu tubes, and saccule contain a limpid hum Suspended in this humour there is found the common sinus and also in the saccul small mass of calcareous powder.

The liquid of the membraneous labyri

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[*] Müller's Archiv. für Anat. Physiol. und wissenschaftl. Medecin. 1835. Heft. II. pp. 173, 174.

[*] Anatomicæ disquisitiones de Auditu et Olfa s. xvi. p. 55.

[†] Op. cit. s. iv. p. 49.

[‡] Observat. Anatom. de aure internâ compa p. xxxii. Præfat.

[§] Op. cit.

olymph or vitreous humour of the ear.
la labyrinthi membranacei. Humor
auris. Fr. *Vitrine auditive.* Germ.
r des häutigen Labyrinths. Die
uchtigkeit des Ohres.—This humour,
istinctly pointed out by Scarpa, fills
all the cavities of the membrane-
ıbyrinth,—that is to say, in the human
ie common sinus, ampullæ, the semi-
r tubes, and saccule. Like the peri-
, it is almost as limpid as water. In
dolymph there are, as has been said,
found suspended calcareous concre-
The endolymph is in birds as limpid
he Mammifera; but in reptiles it is in
l more dense than water and a little
It is viscid in all fishes, but especially
he Chondropterygenous, in which it often
ts itself in the form of jelly. It is also
lecidedly viscid in the Cephalopodous
isca.

e masses of calcareous matter contained
ı the membraneous labyrinth.—In the ear-
of all animals which possess one, there
ound small masses of a chalky nature;
me solid, in others pulverulent. Solid
etions are found in the osseous fishes,
n the Chondropterygenous fishes with free
such as the sturgeon. The chalky mat-
in a pulverulent state in Mammifera,
, reptiles, and in Chondropterygenous
with fixed gills. In the Batrachian rep-
and Cephalopodous Mollusca, the cal-
us matter appears rather under a concrete

iese calcareous masses are best known in
ous fishes, in which they are hard but
e bodies of a determinate shape. In
animals, indeed, they have been erro-
sly considered as analogous to the tym-
c ossicles of the higher Vertebrata. MM.
chet* and Huschke† have lately called
cular attention to the subject, and have
ribed masses of calcareous matter in the
f reptiles, birds, and Mammifera. Scarpa
Comparetti had observed them in the
ıan ear, without, however, detecting their
ıre. But they had been unequivocally
ced before by De Blainville;‡ and pre-
ısly to the first publication of Breschet's
ers on the ear in the Annales des Sciences
urelles, I had also studied them throughout
animal series.
Breschet has proposed for the solid masses
name of *otolithi*, from ους, auris, and λιθος,
is; and for the pulverulent ones that of
conia, from ους, and κονις, pulvis. Otoconia
been translated into German by Lincke §
rsand. Huschke calls the pulverulent matter
ear-crystals, *Ohrkrystalle.* Krause, ear-chalk, *Ohrkalk.*

In the ear of man and the Mammifera in general there are two masses of calcareous matter; one in the common sinus and the other in the saccule. According to Huschke and Barruel they are composed of mucus, carbonate and phosphate of lime, and some animal matter. They are said to be more distinct in the fœtus than in the adult. From my own observations I should say that they exist in the human adult as distinctly as in the fœtus. Concretions are never found in the ampullæ or semicircular canals, either in man or any of the lower animals.

Examined in man and the Mammifera the concretions are suspended in the endolymph, and correspond to the points of the common sinus and saccule where the nervous filaments are implanted.

The grains composing the calcareous mass are held together by a soft mucous tissue.

Huschke describes the grains as crystalline, small six-sided columns, pointed at the ends with three surfaces. They appear to me, under the microscope, to have an oval form, more or less elongated, in man and the mammifera, passing into a spindle shape in birds and reptiles, and, though transparent, they do not present any very decided crystalline form. The particles of chalk examined through the microscope have a somewhat similar appearance, but much smaller. The grains of the ear are of different sizes. Of a mass which I removed from the ear of a middle-aged man, the greatest number had their longest diameter equal to that of the globules of the human blood, that is, about the three-thousandth part of an inch.

There is found in the cochlea of birds a mass
of calcareous matter. Breschet says he ha
found, in cochleæ of the human fœtus, whic
had been dried but not macerated, small masse
of cretaceous matter deposited near the summi
of the cochlea; and Huschke* once found, i
the fluid of the cochlea of a child, a collectio
of microscopical crystals.

Cruveilhier* asks, do the small masses
cretaceous matter, found in the ear of man an
the mammifera, fulfil the same function as th
stones in the ear of fishes? or must they b
considered as a remains only of a part impor
ant in other animals? Breschet says, "th
otolithes and otoconies have, for their use,
communicate to the nervous extremities a mo
vivid and energetic impression than a simp
liquid like the endolymph could do; for t
vibrations of a solid body are much more se
sible for their force and degree of intensity th
those of a liquid body." However this may b
it appears that the development of these co
cretions coincides, in some degree, with t
medium inhabited by the animal; thus, th
are stony in most animals living in water, a
pulverulent in such as exist in air.

The auditory or acoustic nerve.—Nervus a

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* Lib. cit.

† Isis, 1834. Heft. 1. p. 107. 1833. Heft. vii. 676.

‡ De l'Organization des Animaux ou Principes Anatomie comparée, tom. i. p. 451-458. Paris, 22. Also, Cours de Physiologie générale et comrée, &c. Paris, 1829. xii Leçon. p. 399.

§ Das Gehörorgan, &c. s. 176. p. 203. Leipzig. 37.

* Loc. cit.

† Anatomie descriptive, tome iii. p. 524.

ditorius s. acusticus.—Fr. *Nerf auditif ou acoustique.*—Germ. *Der Gehörnerv.*—The internal auditory meatus of the temporal bone appears to end in a cul-de-sac; but, examined more closely, the bottom is found divided into two unequal-sized depressions, an upper and a lower, by a crest, which extends backwards from the anterior and outer wall of the meatus. The upper depression, which is the smaller, is subdivided into two, an anterior and a posterior, by a small vertical pillar. The anterior leads into the aqueduct of Fallopius, and gives passage to the facial nerve. The posterior is almost funnel-shaped, and presents two or three pretty large apertures, and several smaller and less distinct ones. These are the mouths of small canals which lead into the vestibule, and their terminating orifices produce that sieve-like appearance in the pyramidal elevation between the hemi-elliptical and hemispherical depressions, and which extends towards the ampullary dilatations in the superior horn of the vestibule.

The lower and larger depression presents two subdivisions. The anterior and larger corresponds to the base of the axis of the cochlea; it presents a spiral groove or tract—*tractus spiralis foraminulentus*, answering to the turns of the cochlea, and perforated like a sieve by numerous apertures, which diminish in size towards the centre, where there is one opening larger than the rest. The posterior subdivision of the lower depression is a small superficial fossa, perforated by two or three larger, and a great number of smaller apertures, which open into the hemispherical depression of the vestibule, producing the sieve-like spot already mentioned as existing there. Below this superficial fossa there is a pretty large hole, leading into a canal in the posterior wall of the vestibule, which opens by several small orifices, forming he sieve-like spot within the mouth of the ampullary dilatation of the lower extremity of the posterior vertical semicircular canal.

The different minute apertures we have described give passage to the fibrils of the audiory nerve.

The internal auditory meatus is lined by dura mater.

The facial nerve enters the internal auditory meatus along with the auditory nerve. At the bottom of the meatus there is a communication between the two nerves, which was first pointed out by Mr. Swan. Separating from the audiory nerve, the facial leaves the internal meatus, by entering the aqueduct of Fallopius.

From its origin to about where it enters the nternal auditory meatus, the auditory nerve presents most distinctly the delicate-walled ubular structure of brain. Within the meaus it assumes the ordinary thick-walled cylindrical tubular structure of nerves; a circumtance overlooked by Ehrenberg, when he aduced, as a peculiarity of the special nerves of ense, that they presented throughout their ourse the so-called varicose tubular structure.

The auditory nerve divides into two branches —an anterior, or cochlear; and a posterior, or estibular branch,—which externally remain united together as far as the bottom of the meatus. The former is whiter, and has its filaments more compactly bound together than the latter. Examined under the microscope, the cylindrical tubules of the cochlear nerve appeared to me to be larger than those of t vestibular, and to contain, or at least to give o a greater quantity of nervous medulla.

The anterior branch, or cochlear nerve, *n- vus cochleæ*, is something like a flat tape roll on itself longways. It proceeds forwards that depression at the bottom of the internal auditory meatus, already described as corre- ponding to the base of the axis. Here it resol itself into a number of fine filaments, wh enter the apertures in the spiral tract of hol Traversing the small bony canals leading fro those apertures into the substance of the a they enter the bony spiral lamina accordin their turn comes, by bending nearly at a ri angle, and spread out upon it. The first fi ments given off are the largest, the rest gradua diminish in size.

The first turn of the spiral lamina is suppli by those which enter the first turn of the spir tract of holes; the second turn receives t filaments which traverse the bony canals, in which the fine apertures of the second turn the spiral tract lead; and the last half turn i supplied by that large bundle of filaments terminating the nerve, and which, entering th axis by the large opening in the centre of th spiral tract, emerges at its summit.

The vestibular nerve, *nervus vestibuli*, whi presents a small gangliform enlargement, d vides into three branches. The uppermost which is the largest, lies in the depression behind the entrance to the aqueduct of Fallopiu Its filaments having penetrated the vestibu by the small apertures of the canals alrea mentioned in the pyramidal elevation, arran themselves into three fasciculi; of which one distributed to the common sinus, and the oth two to the ampullæ belonging to the superi vertical and to the horizontal semicircular tu

The fibrils of the next branch enter the v tibule by the apertures at the bottom of t hemispherical depression, and terminate in t saccule.

The third, or lowest branch, which is t smallest, enters that canal described in the p terior wall of the vestibule, and which op by a sieve-like spot within the ampullary di tation of the posterior semicircular canal. fibrils are distributed to the ampulla of t posterior semicircular tube.

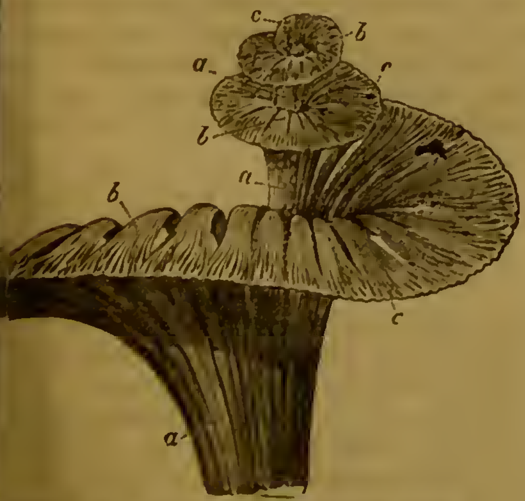
Such is the description of the divisions the auditory nerve as given by most autho and as it has appeared to me in the exami tions I have made. Krause and Breschet, ho ever, describe the mode of division different The former says the nerve of the saccule con off from the cochlear nerve; the latter, that cochlear nerve (which he calls the poster fasciculus of the auditory nerve) gives off b the saccular nerve and the filaments to the p terior ampulla. I have not at present an opp tunity to repeat my examination of the par

me to say positively which description
st correct.*
rvous fibrils of the cochlea, according
iet, traverse the osseous zone of the
nina under the form of cylindrical
which, in the *middle zone*, become
anastomose by loops. These loops
ningled with small osseous particles.
outer margin of the middle zone, the
na leaves the nervous filaments, and
rm the framework of the membraneous
lst small globules are seen irregularly
ited around the convexity of the loops
: filaments form by their anastomoses.
however, is not so unequivocally dis-
Breschet pretends. What I have been
:e in regard to the termination of the
n the spiral lamina, is simply this:—
ilar structure of the nervous filaments
unong grains of nervous matter ar-
into a sort of expansion. There is
that can be called a termination in
Mueller thinks the nervous fibrils do
ı loops in the bird's cochlea. "But,"
eller, "it is of no consequence, in the
state of the physiology of the nerves,
the nerves of sensation form at their
ions loops or not."

anus† found a papillary termination
ervous filaments, not only in the retina,
in the nervous expansions of the ear
;e. The papillæ of the auditory nerve
on the spiral lamina of the cochlea in
mice. The osseous part is entirely
with filamentous papillæ, lying close
. Gottsche also found the ends of the
of the cochlea in hares and rabbits club-
In the hare, the nervous cylinders ter-
in an oval knob.

ollowing figures from Breschet illustrate
vs of the mode of termination of the
filaments of the cochlea.

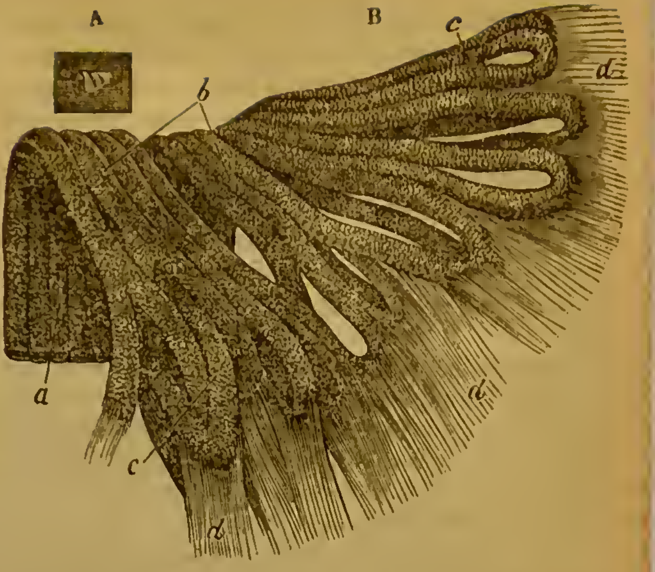
Fig. 9.



cochlear nerve entirely isolated. (Magnified.)

, a. trunk of the nerve; *b, b, b.* its filaments
osseous zone of the spiral lamina; *c, c, c.* the
omoses in the middle zone.

Fig. 10.



A, *a small piece of the spiral lamina, natural size, as seen from the surface corresponding to the scala vestibuli.*

B, *the same part considerably magnified to show the globular structure (?) of the nerves and the mode in which the neurilemma leaves them at the place where they form their anastomoses.*

a. Portion of the trunk of the cochlear nerve; *b.* fasciculi lodged in the osseous zone of the cochlea; *c, c.* anastomoses in the middle zone; *d, d, d.* the neurilemma leaving the nervous loops, interlacing and forming the basis of the membraneous zone.

As to the mode in which the nervous filaments enter and terminate in the membraneous labyrinth. The nervous filaments, according to Scarpa, before penetrating the vestibule of the small bony canals, lay aside their thicker sheath, and become softer and whiter. The filaments expand on the parts for which they are destined, appear to form a network, and, having penetrated into the interior, are resolved into a nervous pulp which lines the inner surface. Scarpa compares this nervous expansion in the saccule to the retina.

According to Breschet's account, the nervous filaments, in penetrating into the interior of the different membraneous pouches, are accompanied by a sheath furnished by the pouch itself, which is folded inwards, and accompanies them until these filaments spread themselves out. Hence it is that, at the entrance of the nerves, the walls of the pouch are always thicker, and form a more or less considerable projection in the interior. This prominence is slight in the saccule and common sinus, but very well marked in the interior of the ampullæ, where it forms a sort of incomplete septum across; a structure which is small in man and the mammifera, but very much developed in birds and the higher reptiles.

At those prominences the nervous filaments, says Breschet, present anastomosing loops, and the neurilemma leaving them to be incorporated with vessels, and thus to form the framework of the membraneous labyrinth, the nervous globules come into immediate contact with the mass of calcareous matter.

What I have said of Breschet's account of

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n the sheep I have found the division of the
ry nerve corresponding to the first description
above.

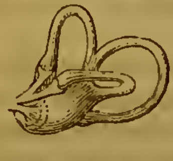
Beiträge, &c. 1sten Bandes 2tes Heft. Neue
suchungen ueber die organischen Elemente
iierischen Koerper, p. 55. Bremen, 1835.

the terminations of the cochlear nerve is also applicable here. The filaments of the nerves of the common sinus and saccule expand in a fan-like manner on their walls, and having penetrated them, are resolved into a nervous layer like the retina, situated on the inner surface of the walls of those cavities. This nervous layer is, in the human ear, pervaded by extremely minute transparent fibres. In the rabbit I have distinctly seen, with a doublet magnifying 150 diameters, a fibrous or tubular structure similar to that of the retina first discovered by Ehrenberg.

As regards the entrance of the nerves of the ampullæ, Steifensand* gives a similar but more detailed account than Breschet. He says, the nerve, after having embraced in a forked manner about a third of the circumference of the ampulla, enters the wall of it.

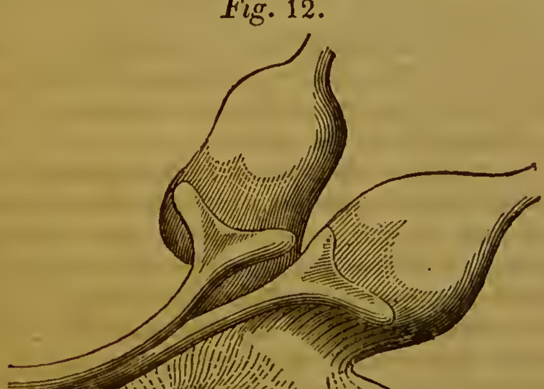
Resolving itself now into infinitely fine filaments, the nerve penetrates the septum which lies quite close to the opening in the common sinus, and which resembles a semilunar eminence projecting into the interior. It now covers the surface of the septum and a circumscribed portion of the adjacent inner surface of the wall of the ampulla with an extremely delicate nervous pulp. The two ends of the semilunar septum, gradually flattening and spreading out, lose themselves in the wall of the a pulla.

Fig. 11.



Common sinus, together with the ampullæ and semicircular tubes, and the entrance of the nerves into them. (From Steifensand.)

Fig. 12.



The ampullæ of the superior and horizontal semicircular tubes, with a part of the common sinus. The fan-like expansion of the nervous fibrils on the latter is seen, and also the fork-like expansion of the nerves on the outer surface of the ampullæ. Magnified. (From Steifensand.)

Fig. 13.

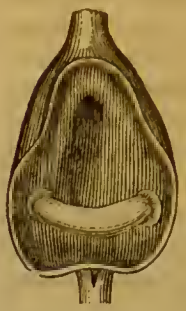


Fig. 14.

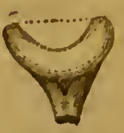


Fig. 15.

Fig. 244, *(from Steifensand.) The am opened in order to exhibit the septum.*

Fig. 245, *(from Steifensand.) The fork-like mination of the nerve of the ampulla and the semi septum, having the appearance of pure nervou stance.*

Fig. 246, *(also from Steifensand.) The ex sion of the nervous pulp over the septum.*

Bloodvessels of the labyrinth.—The cipal artery of the labyrinth is the *art auditiva interior.* It is a branch of the lar. It enters the internal auditory m along with the nerve of the seventh pair, at the bottom of it divides into two bran the cochlear and vestibular arteries, w enter the labyrinth with the correspon nervous filaments.

The cochlear artery, *arteria cochleæ,* div into a number of branches which enter cochlea by the spiral tract of holes; one in ticular, *arteria centralis modioli,* passes thro the central canal of the axis as far as the of the cochlea.

The vessels of the walls of the cochlea more numerous in the scala vestibuli tha the scala tympani. The arterial branche the spiral lamina anastomose with each at the outer margin of the osseous zone. I the convexity of the anastomotic arches nu rous small arteries arise and run parallel a as the outer margin of the middle zone, w they again anastomose, forming loops infi smaller, from the convexity of which cap vessels run. These capillary vessels term in a sinus of a venous nature, lodged i substance of the outer margin of the s lamina.

The vestibular artery, *arteria vestibuli,* plies the vestibule and semicircular cana gether with their contents, the saccule, co sinus, ampullæ, and semicircular tubes sends a branch along the surface of the s lamina corresponding to the vestibular The *stylo-mastoid artery,* a branch of the *p rior auricular,* sends a twig to the ex semicircular canal. The *occipital arter* frequently sends twigs to the labyrinth.

The bloodvessels form a beautiful plex the ampullæ, and considerable trunks run the whole length of the semicircular tubes ported on their surface by a delicate ce tissue, which forms the vehicle for the p of the small lateral branches given off t walls of the tubes.

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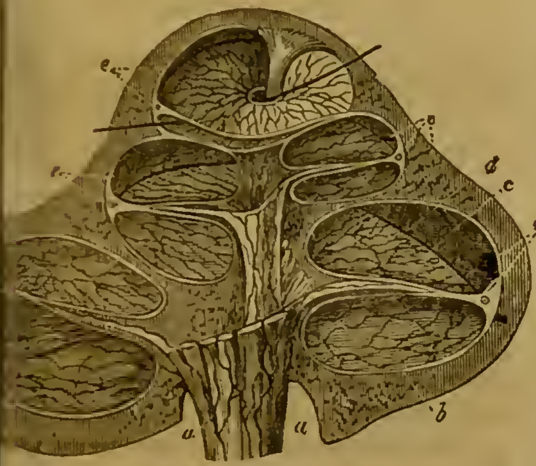
* Müller's Archiv. für Anatomie, Physiologie, und wissenschaftliche Medecin, 1835. Heft. ii. s. 174 and 184.

uch is known of the veins of the laby- 'he internal auditory artery is accom- y a corresponding vein which carries blood from the labyrinth, and empties he superior petrosal sinus. Another s Weber,* goes perhaps from the laby- ough a small opening in the cleft of luct, and empties itself into the trans- us.

veins of the cochlea, some, according iet, accompany their arteries; others sinus, lodged in the substance of the rgin of the spiral lamina. Near the the cochlea, this sinus communicates veins of the vestibule.

ng is known of the absorbents of the ..

Fig. 16.



on of the cochlea parallel to its axis, showing ution of the vessels in its interior. It is the t are delineated, but their distribution is same as that of the arteries. Magnified. reschet.)

eins accompanying the trunk of the coch- e, and penetrating the nervous branches spiral lamina; *b.* first anastomoses at the of the osseous zone; *c, c.* second anasto- the periphery of the middle zone; *d.* last es, which are almost parallel, occupying braneous zone; *e, e, e.* venous sinus in heral margin of the membraneous zone.

CESSORY PARTS OF THE APPARATUS OF HEARING.

iese parts, the auricle collects the so- undulations, and the auditory passage s them to the middle ear or tympanum, hey are modified and transmitted to the part of the apparatus, the ear-bulb.

npanum is found in reptiles, birds, and ifera, a perfect external ear only in the ifera. The lip-like folds of skin before mbrana tympani, in some birds and rep- ay, however, be considered rudiments external ear. Among the Mammifera, tacea have no auricle, and only a very ted auditory passage.

vas said that the tympanum exists in a number of animals than the cochlea. efers to a discovery made by Weber,† prolongation of the swimming-bladder in the herring, in the cyprinoid fishes, in silurus glanis, and in several species of cobitis, has a connexion with the membraneous labyrinth in the same manner that the prolongation of the mucous membrane of the throat, forming essentially the tympanum and Eustachian tube, is extended to the surface of the labyrinth; and moreover, that in all those fishes, with the exception of the herring, there exist bones analogous to the tympanic ossicles in the higher animals.

1. *The middle ear, or tympanum, and its appendages.*

The cavity of the typanum, cavitas tympani; Fr. *caisse du tympan ou du tambour;* Germ. *die Trommelhöhle oder Paukenhöhle.*—The cavity of the tympanum is a space lying at the peripheral surface of the ear-bulb, and measuring from above downwards as well as from before backwards about four-tenths of an inch, and from without inwards about three-twentieths of an inch. It is bounded internally by the outer wall of the osseous labyrinth; externally by a vibratile membrane, the membrana tympani, and that portion of the temporal bone into which it is framed. Anteriorly a canal, the Eustachian tube, leads from it into the throat; and posteriorly and superiorly it communicates with the mastoid cells.

The cavity of the tympanum is traversed by a chain of small bones, extending from the membrana tympani to the vestibular fenestra, and is lined by a very delicate membrane of a fibro-mucous character, which is prolonged into all its sinuosities and dependent cavities. This membrane is moreover reflected on the parts which traverse the cavity, and envelopes them. The lining membrane of the tympanum is continuous through the medium of that of the Eustachian tube, with the mucous membrane of the throat.

A condition essential to the due performance of the function of the tympanum is that the external air have free access to its cavity.

Examined on the dry bone, the *inner wall* of the tympanum presents a considerable eminence; behind and below which is an opening somewhat of a triangular form, and in a fossa above it another opening, about twice the size of the preceding, and of an ovoid shape. From the description which has been already given of the osseous labyrinth, it will be immediately perceived that the eminence in question, called the *promontory*, is that which the commencement of the cochlea forms; that the opening below and behind it is the *fenestra rotunda* or *cochlear fenestra*, and the opening above it the *fenestra ovalis* or *vestibular fenestra.*

The surface of the promontory is marked by a groove; sometimes instead of a groove there is a canal. This groove is continuous below with a canal, several lines in length, which opens in that depression in the partition betwixt the lower orifice of the carotid canal and the foramen lacerum posterius. Above, in front of the vestibular fenestra, the groove again runs into a canal which proceeds forwards and upwards between the canal for the internal muscle of the malleus and the commencement of the

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Hildebrandt's Anatomie.

Aure et auditu Hominis et animalium, 1820.

aqueduct of Fallopius, and opens on the upper surface of the petrous portion of the temporal bone outside and in front of the hiatus of Fallopius. This canal, first accurately described by Arnold,[*] and called by him the tympanic canal, *canalis tympanicus*, is traversed by the nerve of Jacobson, which establishes a communication betwixt the glosso-pharyngeal and the otic ganglion. Besides this groove there are several others corresponding to the branches of the tympanic plexus of nerves.

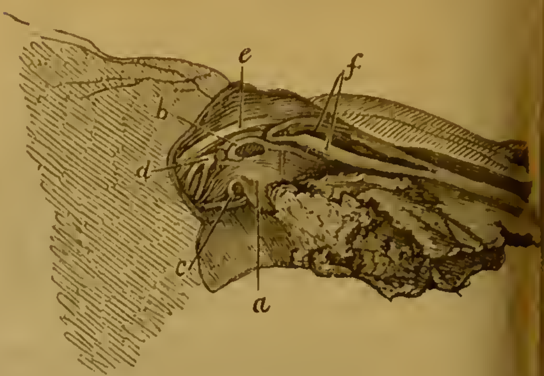
The opening below and behind the promontory, the *fenestra rotunda* or *cochlear fenestra*, leads, by a short infundibuliform canal directed obliquely inwards, into the lower or tympanic scala of the cochlea. Looking into this very short canal sideways, a groove is remarked encircling the margin of its inner orifice. This groove receives the circumference of the secondary membrane of the tympanum.

The opening above the promontory, the *fenestra ovalis* or *vestibular fenestra*, has already been described in speaking of the vestibule. All that we have to add here is that it is surrounded externally close to its edge by a small channel or groove.

Above the vestibular fenestra and running in much the same direction as its long diameter is a round elongated ridge, within which is the aqueduct of Fallopius. Below this ridge and behind the vestibular fenestra is a small mammillary or pyramidal eminence, called the pyramid, *eminentia papillaris s. protuberantia pyramidalis*. The apex of the pyramid, directed forwards and a little outwards, presents an opening leading into a canal, which extends backwards and downwards, then becoming vertical lies in front of the lower part of the aqueduct of Fallopius. In the thin lamina of bone which separates the two canals there is an aperture. The muscle of the stapes is lodged in the canal, and its tendon issues by the aperture in the apex, of the pyramid. About one-sixth of an inch behind the pyramid and close to the groove for the insertion of the circumference of the membrana tympani is the opening by which the chorda tympani, accompanied by an artery, enters the tympanum.

In front and a little above the vestibular fenestra, and on the anterior extremity of the prominence of the aqueduct of Fallopius, is a tubular projection with a wide open mouth directed outwards. This tubular projection, which is generally found incomplete in the dry bone, in consequence of being composed of a very thin brittle substance, is what has been called the *cochleariform process*. It is the continuation, bent at nearly a right angle outwards, of the canal or half canal, about half an inch in length, and destined for the reception of the internal muscle of the malleus, which lies above the osseous part of the Eustachian tube, and is separated from it merely by a thin lamina of bone, the continuation that forming the tubular projection.

Fig. 17.



The inner wall of the tympanum.

a. Promontory; *b*. vestibular fenestra; *c*. c lear fenestra; *d*. pyramid; *e*. eminence of aqueduct of Fallopius; *f*. cochleariform p and half canal for the internal muscle of the leus.

The outer wall of the tympanum is for by the membrana tympani and the inner tremity of the osseous part of the external ditory passage, in which the membrana tym is framed.

Osseous portion of the auditory passag This leads from the outside of the tem bone. In front of it lies the glenoid ca and behind it is the mastoid process. I about three-quarters of an inch long. course is from without inwards and f behind forwards, at first a little upwards then downwards. It is wider at either e mity than in its middle. A cross sectio the passage presents an elliptical orifice, long diameter of which is directed from be forwards and from below upwards. Its e mities are cut obliquely in such a way tha ternally the anterior wall exceeds the poste whereas at the outer orifice the posterior exceeds the anterior in length.

The margin of the *outer orifice* is rough irregular to give attachment to the cartilagi portion of the passage and to the auricle. within the *inner orifice* the osseous aud passage is grooved all round except at its u part. This groove is for the reception o circumference of the membrana tympani.

In the fœtus the osseous portion of the tory passage is a mere ring of bone, the *panic ring*, incomplete at the upper part w the groove in the adult is wanting. The panic ring serves as a frame for the mem tympani. On the inner surface of the sup extremity of the anterior crus of this incom ring of bone there is a broad superficial gr into which the processus gracilis of the m is received.

By-and-bye the tympanic ring is uni the temporal bone, and in process of tin part outside the groove grows outwards so form that plate of bone, thick behind, th front, rolled together in the form of an in plete tube, which in the adult compos lower, the anterior, and the posterior w the osseous auditory passage.

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[*] Ueber den Canalis tympanicus und mastoideus, in Tiedemann's, Treviranus, und Gmelin's Zeitschrift für die Physiologie, B. iv. Heft 2, No. xxi. p. 284.

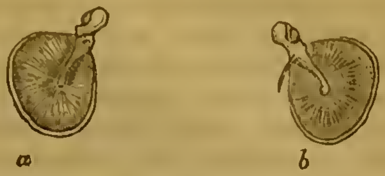
ympanic ring lies immediately behind
oid cavity of the temporal bone, from
s anterior part is separated by a fissure.
ıdle part of this fissure, together with a
icating the whole, remains permanent
ıdult, and is known by the name of
f Glasser. Its internal orifice is, in the
it is in the young bone, in the outer
the tympanum, anteriorly of, and close
oove for the reception of the membrana
. The fissure of Glasser gives passage
igament, or so-called great external
of the malleus, which is inserted into
essus gracilis of the malleus. The
ympani does not actually pass through
ıre of Glasser as commonly described,
I. Huguier* has shown, through a par-
anal, extremely narrow and about half
long, which runs in the line of the
and opens at the re-entering angle be-
ne squamous and petrous portions of
ɔoral bone.

brane of the tympanum, (membrana tym-
r. *la membrane du tympan ou du tam-*
Germ. *das Trommelfell oder Pauken-*
. proper membrana tympani exists only
and mammifera. In reptiles there is a
perfect representation of one. In birds
ıbrana tympani is convex externally, in
ımifera, on the contrary, it is concave.
ıvexity externally in birds forms a very
nt distinguishing character of the class.
etaceous mammifera the membrana tym-
hick, and presents a prolongation like
of a funnel into the cavity of the tym-

membrana tympani is situated at the
of the external auditory passage, be-
which and the cavity of the tympanum
erposed like a partition. It is a thin,
nsparent, glistening, dry-looking mem-
Its shape is an oval, truncated at one
y, the upper. Rather more than the
alf of its vertical diameter is traversed
ıandle of the malleus, which, when the
ne is examined on the living subject by
f the speculum auris, appears directed
ove downwards and backwards.
ongest diameter of the membrana tym-
hich is directed from above downwards,
ɔm behind forwards, is about eight-
hs of an inch, and its shortest, that from
forwards, somewhat less than seven
hs of an inch. It is fixed by its cir-
nce in the circular groove already men-
at the inner orifice of the osseous part
xternal auditory passage, or in the fœtus,
panic ring; and as in the adult the ori-
ct obliquely from behind forwards,
bove downwards, and from without in-
so is the direction of the membrane.
it forms, with the upper and posterior
the auditory passage, an obtuse angle,
th the lower and anterior wall, an acute

ıre 249 represents the adult membrana tympani of the right side; *a.* as seen from the auditory passage; *b.* as seen from the tympanum. Its shape, size, the mode in which the malleus is connected with it, and the cartilaginous ring which forms its circumference, are sufficiently well shown.

Fig. 18.



The membrana tympani does not present plane surfaces. On the contrary its centre is drawn inwards, so that it is concave externally, and convex internally. This disposition of the membrana tympani depends on its connexion with the handle of the malleus. The latter being fixed in its whole length to considerably more than the upper half of the vertical diameter of the former, and having an inward direction inferiorly, the membrana tympani is, as it were, drawn inwards to it, hence the concavity externally.

As regards the composition of the membrana tympani, it consists of a proper membrane and two borrowed layers, one of which, covering the external surface of the proper membrane, is a delicate continuation, in the form of a blind end, of the lining of the auditory passage, and the other, situated on the inner surface, is a continuation of the delicate membrane which gives a lining generally to the cavity of the tympanum. The latter adheres very closely to the proper membrane, the other not so intimately, as it readily separates from it by putrefaction, and can be drawn out along with the rest of the epidermis of the external auditory passage in a cul-de-sac.

Structure of the proper membrane.—The proper membrane can be divided into two layers, an outer thin one, consisting of radiating fibres, and an inner thicker layer, which is less distinctly fibrous, though when torn it does indicate a fibrous disposition, and that in a direction opposite to the former. The radiating fibres run from its circumference towards the centre, to be fixed to the handle of the malleus along its whole extent. Towards the centre they become stronger, and being, of course, more aggregated, the layer which they compose is thicker and more compact in the centre than towards its circumference. The fibres which cross the radiating ones are also more aggregated at the centre. They run parallel with the handle of the malleus, and turn round its extremity. At the circumference of the proper membrane, there is a thick firm ligamentous or cartilaginous ring, (*fig.* 249,) which is fixed in the groove of the bone. This ligamentous ring appears to be formed by an aggregation of the circular fibres interwoven with the peripheral extremities of the radiating ones. The part of the membrana tympani midway between its centre and circumference is the thinnest.

The radiating fibres have been supposed to

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veilhier, Anatomie Descriptive, tome iii.

be muscular by Sir Everard Home and others, but this has not been confirmed by microscopical examination.

Mr. Shrapnell[*] describes at the anterior and superior part of the membrana tympani, above the short process of the malleus and its suspensory ligament, and where the groove in the bone is deficient, a flaccid tissue, composed of irregularly arranged fibres, to which he gives the name of *membrana flaccida*, in opposition to the rest of the membrana tympani, which he calls *membrana tensa*. This flaccid tissue is more developed in some of the lower animals, the sheep and hare for instance, than in man, and can be readily made to bulge out towards the auditory passage by blowing air into the Eustachian tube. But we cannot look upon it, with Mr. Shrapnell, as properly forming any part of the membrana tympani. It is merely a mass of dense, reddish, vascular cellular tissue, surrounding the neck of the malleus, and continuous with a similar tissue found under the lining integument of the upper wall of the osseous auditory passage. It is this same tissue which has been described as a muscle, and sometimes as a ligament.

The membrana tympani has been said to present in the natural state a perforation closed by a valve. Rivinus,[†] though not the first to mention it, dwelt on it, however, in a particular manner, hence the perforation has been called *hiatus Rivinianus*. The subject has been more recently taken up by Wittmann and Vest.[‡]

The membrana tympani receives a nerve from the third division of the fifth, which has communications with filaments of the chorda tympani.

To resume our description of the cavity of the tympanum:—In the upper wall of the tympanum there is an excavation for receiving the upper part of the incus, and leading from that, at the upper and back part of the tympanum, is a short, wide, triangular canal, with a rough cellular surface. This is the passage to the mastoid cells, through the medium of a large cell, *sinuositas mastoidea s. sinus mammillaris, s. antrum mammillare*, which already exists in the young bone between the squamous and petrous portions.

The mastoid cells are cavities in the mastoid process, all communicating with each other. They are quite irregular in regard to size, number, and relative situation. In early life, as the mastoid process is not fully formed, they do not exist, they are only found completely developed in the adult.

Inferiorly, the cavity of the tympanum forms a sort of furrow, which presents nothing particular. It is bounded by the plate of bone which forms the outer wall of the jugular fossa.

Anteriorly, the cavity of the tympanu
opens into the osseous portion of the Eustach
tube.

The ossicles or small bones of the ear (*o*
cula auditus s. aurium, Fr. *osselets de l'ouv*
Germ. *die Gehörknöchelchen*, or *Gehörbeinchen*
In the upper part of the cavity of the tym
num, there are three small bones articu
with each other, and forming a chain w
reaches from the membrana tympani to the
tibular fenestra. The bones are named *mal*
incus, and *stapes*, from their resembling mo
less respectively a hammer, an anvil, and
stirrup iron.

The innermost and most essential is th
pes; it is it alone which in birds and re
remains, when the others have disappeared,
been reduced to merely cartilaginous p
The stapes is engaged in the vestibular f
tra.

The outermost of the chain, the malleu
in connexion with the membrana tympani.

The hammer bone, (*malleus,*) Fr. *le mar*
Germ. *das Hammer*, presents a head, a nec
handle, and two processes, one longer, and
shorter.

The head, *caput s. capitulum*, is round
smooth on one surface, and on the other
sents a saddle-shaped depression, surro
by a small elevated border. The depress
articulates with the incus, and the border
the attachment of the synovial capsule of
minute joint.

The neck, *collum s. cervix*, is flattened in
diameter, and joins the handle at an ob
angle.

The handle, *manubrium mallei*, comp
from the side corresponding to the arti
depression to the opposite side, and dimi
ing in thickness towards its extremity, f
together with the short process, a double c
like an Italic *ʃ*. The extremity is also c
pressed, as if beaten flat, but in an opposi
rection, so that the broad surfaces of the e
mity correspond to the edges of the rest o
handle.

Short or blunt process, *processus brev*
obtusus. From the projecting side of th
gle formed by the junction of the neck
manubrium, this process, which is short, t
and conical, rises.

The long or slender process, *processus l*
s. gracilis, s. spinosus, s. Folii, springs fro
neck, and from that side of it which
ponds with the non-articular surface o
head. The long process is of consi
ble length, and terminates in a broad,
spatula-like extremity, first described by l
although the commencement or root o
process itself had been previously delin
and described by Folius. The long proc
generally found broken off, either from its
so slender, or from its having been, espe
in old subjects, united to the groove in w
is lodged.

The anvil bone, incus, Fr. *l'enclume*, ss.—This has been compared, also, to d molar tooth. It is divided into a t two processes, or crura.

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[*] On the form and structure of the membrana tympani, in London Medical Gazette, vol. x. p. 120. London, 1832.

[†] De auditus vitiis, Lipsiæ, 1717, 4, p. 32. Tab. adj. Fig. 1, *b*. et fig. 2, *b*.

[‡] Ueber die Wittmannsche Trommelfellklappe, in den medizinisch. Jahrbüchern des oestr. Staates. Bd. v. Wien, 1819, p. 123, 133.

[*] Boerhaave Prælect. in Institt., Prop. 358.

dy, *corpus*, presents a concave articu-:, by which it is joined to the malleus: iis surface is a groove, (particularly broad on the side towards the laby-t is, the side on which the lenticular rojects,) for the insertion of the articu-e.

orter of the two processes, *crus s. pro-terior s. brevis*, is blunt at its apex, ressed from one side to another.

iger process, *crus s. processus inferior* is more slender, and becomes gradually wards its extremity, where it is slightly and where it presents, supported on a ny pedicle, given off at a right angle side, the lenticular process, *processus ris incudis*;*—a small oval plate so that a line drawn through the long of it would intersect obliquely a line nding to the long crus of the incus. surface of the lenticular process is and is destined to articulate with the nding concave surface on the head of es. The lenticular process has been, ill, often described as a separate bone, e name of *os lenticulare*.

tirrup bone, (stapes). Fr. *L'etrier*. *Der Steigbügel*.—Exactly like a stirrup, e presents a base, two crura, and a head, e crura unite.

ase, *basis*, the essential part of the bone, isely the same shape as the vestibular to which it is applied, only a little The arched margin of the base cor-s to the upper edge of the fenestra, and nted margin to the lower edge.

urface of the base corresponding to the ar fenestra is slightly convex. The other s grooved; but the groove is subdivided lge, which extends obliquely along it ays, and which is continuous at its ex-s with the upper margin of the groove nner surface of one crus, and the lower of the groove of the opposite crus. argin of the base projects like a ledge the insertion of the crura.

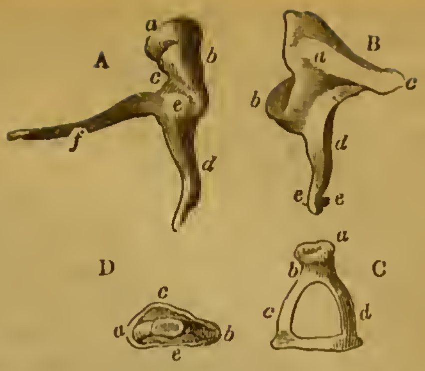
e two *crura*, one is shorter and straighter e other; both are grooved on the surfaces ng each other, and the grooves are con-into that just described in the base, in way that the groove of one crus is con-into one of the divisions, and the groove other crus into the other.

head, *capitulum*, somewhat oblong and esents a superficial depression on its top, e from above downwards, and from with-wards, for receiving the convex articular e of the lenticular process of the incus. is sometimes an appearance of a *neck* rting the head.

ition, connexions, and articulations of the bones of the tympanum.—The handle of the malleus is fixed to the membrana tympani. The articular surface on the head of the malleus, to the corresponding surface on the body of the incus, and the long process of the incus, is through the medium of its lenticular process articulated with the stapes. These two joints are furnished with small articular capsules.

The head of the malleus lies in the upper space of the tympanum, above the upper margin of the membrana tympani. Its articular surface is directed obliquely backwards and inwards. The surface of the neck, corresponding to the prominence of the angle which it forms with the manubrium, is hitched like a shoulder under the upper part of the circumference of the inner extremity of the auditory passage. The handle of the malleus, it has been said, is compressed from one side to another, so that it presents two flat surfaces and two edges or ridges. That edge or ridge which is continued down from the short process is turned outwards, and corresponds to the membrana tympani; into it, indeed, along its whole extent, the central extremities of the radiating fibres of that membrane are inserted. The extremity of the handle of the malleus, which is curved forwards and outwards, is compressed, but in a direction contrary to the rest of the handle; so that one of the flat surfaces, that corresponding to the outer ridge of the rest of the handle, is connected with the membrana tympani at a point below its centre, and nearer its anterior edge. It is at this point that the bottom of the cavity is which the membrana tympani presents externally. At its upper part the membrana tympani is pushed outwards by the short process of the malleus, which projects towards the auditory passage.

Fig. 19.



Small bones of the tympanum of the left side, magnified considerably more than twice. (From Soemmerring.)

A is the malleus seen from the side corresponding to the membrana tympani: *a.* head; *b.* articular surface; *c.* neck; *d.* handle; *e.* short process; *f.* long process.

B. The incus seen from its outer surface also: *a.* body; *b.* articular surface; *c.* short crus; *d.* long crus; *e e.* lenticular process.

C. The stapes: *a.* head; *b.* neck; *c.* anterior and less bent crus; *d.* posterior and more bent crus; *e.* base.

D. A fore-shortened view of the stapes: *a.* anterior and less curved crus; *b.* posterior crus, the two are seen uniting at the head, the articular surface of which is seen; *c.* base.

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lumenbach, Geschichte, und Beschreibung enschl. Knochen, s. 50, p. 145.

The long process of the malleus is directed forwards, and lies in a groove within the anterior part of that for the reception of the membrana tympani, and close to the fissure of Glasser.

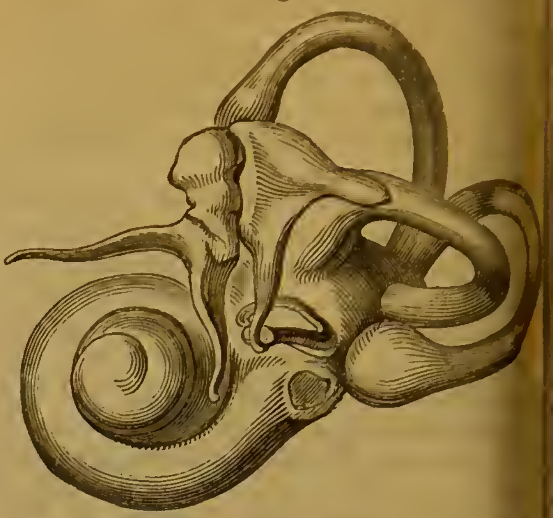
To the top of the head of the malleus, a ligament extends downwards from the upper wall of the cavity of the tympanum. Another ligament, known also under the name of the *great external muscle of the malleus*, proceeds from the spinous process of the sphenoid bone backwards and inwards, through the fissure of Glasser, and is inserted into the long process of the malleus. A third ligament has been described, as arising from within the upper and posterior margin of the inner orifice of the auditory passage above the margin of the membrana tympani, and proceeding downwards and inwards to be inserted into the handle of the malleus below the short process, close to the place where the connexion between the handle of the malleus and the membrana tympani ceases. Of this ligament, which has also been described as a muscle, *small external muscle of the malleus*, there is not much trace, except in the reddish cellular tissue already mentioned.

The body of the incus lies in the upper and posterior part of the tympanic cavity. Its articular surface, corresponding to that of the malleus, is directed forwards, and a little upwards and outwards. The articulating surfaces of the two bones are incrusted with cartilage, and the joint is provided with a synovial membrane, which is strengthened by ligamentous fibres. The short branch is directed horizontally backwards towards the entrance into the mastoid cells, and is there fixed by means of a short and broad ligament, which arises from a small pit in the outer wall, and embracing its extremity, is inserted on it. The long branch extends perpendicularly downwards, almost parallel with the handle of the malleus, but nearer the inner wall of the tympanum, towards which its extremity, bearing the lenticular process, is curved.

The *stapes*, situated lower down in the cavity of the tympanum than the other bones, lies with its base applied to the vestibular fenestra, to the circumference of which it is closely fixed by a circular ligament, *ligamentum annulare baseos stapidis*. This ligament springs from the margin of the vestibular fenestra, and is inserted into the jutting margin of the base of the stapes all round. Besides this ligament, there are reflections of the membrane lining the tympanum, and of that lining the vestibule. The connexions of the base of the stapes with the vestibular fenestra are such as to admit of some degree of movement, but not to any very great extent,—so little, that it would seem one object of the mechanism of the fenestra ovalis, and its closure by the base of the stapes, was merely to interrupt the continuity of the osseous walls of the vestibule.

The short branch of the stapes is in front; the long branch behind, and its head outwards, where it meets and articulates with the lenticular process of the long branch of the incus. This articulation presents also cartilages of incrustation, and a minute synovial capsule, t gether with strengthening ligamentous fibre

Fig. 20.



The small bones connected together, and their to the osseous labyrinth. Left side. Mag (From Soemmerring.)

Muscles of the small bones.—Some anato admit four muscles : three attached to the leus and one to the stapes. Of the three tached to the malleus, two are described as ba for their action the relaxation of the mem tympani; but these so called *laxatores t pani* are merely ligaments, and have been scribed above as such. I agree with Ha bach,[*] Breschet,[†] and Lincke,[‡] that two mu only can be distinctly demonstrated, and two are both tensors of the tympanum. relaxation, or state of rest of the memb tympani, takes place of itself, as Trevi remarks, when the tensors cease to act; l a relaxator muscle of the membrana tym was not required.

Muscle of the malleus, *musculus int mallei s. tensor tympani.*—This muscle occu the canal, or half canal, which was describ lying above the osseous part of the Eustac tube. It arises from the posterior and u part of the sphenoid bone, from the sup part of the cartilaginous portion of the E chian tube, and also from an aponeurotic sh which lines the canal, or completes the gr in which it is lodged. Its fibres proceed before backwards, and terminate in a sle tendon, which bending at a right angle, rope over a pulley, enters the cavity of tympanum, through the tubular projectio ready described as a continuation of the c in which it lies. Having entered the tympan it proceeds outwards, and is inserted in slight elevation, sometimes remarked on inner and anterior surface of the handle o malleus below the long process, and al little below and opposite the root of the

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[*] Disquisitiones anatomicæ circa musculos internæ hominis et Mammalium, &c. Basileæ, p. 20.

[†] Op. cit. s. xxxiii.

[‡] Das Gehörorgan, &c. Leipzig, 1837, p. s. 114.

[§] Biologie, Band. vi. p. 376.

The muscle of the malleus receives
s branch from the otic ganglion.

e action of this muscle, the handle of
eus is drawn inwards and forwards,
e head is moved in the opposite direc-
consequence of the bone moving on its
cess as on an axis. The result of this
nt of the bone is, that the membrana
, which is attached to the handle of the
in its whole length, is also drawn in-
nd stretched. Besides the tension to
e membrana tympani is thus subjected,
of the stapes is forced against the ves-
enestra, in consequence of the move-
mmunicated by the head of the malleus
cus, which tends to press inwards the
remity of the latter.

le of the stapes, M. stapedius.—This is
and takes origin in the cavity of
amid already described. Much paler
aller than the preceding muscle, it is
into the posterior and upper part of the
the stapes by a slender tendon, which
y the aperture in the summit of the py-
nd proceeds downwards and forwards
rmination.

stapedius muscle receives a nervous fila-
om the facial nerve.

first effect of the action of this muscle
to press the posterior part of the base of
es against the vestibular fenestra. At
e time the long branch of the incus will
n backwards and inwards, and the head
nalleus being, by this movement of the
ressed forwards and outwards, its han-
be carried inwards, and the membrana
i thus put on the stretch. Breschet
e muscle of the stapes a *laxator*, but I
now on what grounds.

endie* mentions the circumstance that
stapedius muscle of the ox and horse,
s imbedded a small lenticular bone.
or Berthold of Göttingen† has more
alled attention to the same circumstance.
d has not found this bone in man, nor
nor deer, nor goats, nor swine. In the
calf it is about one-half to three-fourths
e in its longest diameter, and one-third
hortest, and lies surrounded by the mus-
nd tendinous substance where the for-
sses into the latter. In the horse it is a
earer the lower margin of the muscle and
, and is much smaller than in the ox;
er, it is not round, but is a longish plate,
hat thicker in the middle.

the place where the stapedius muscle is
d into the stapes, Hyrtl‡ has sometimes
in the human ear a small process of bone
in some cases was so long as to extend
into the belly of the muscle itself. Teichmeyer* has described this free bone of the stapedius muscle as constant in man.

Having described the walls and contents of the cavity of the tympanum, we come now to speak of the membrane which lines it.

The lining membrane of the cavity of the tympanum is in continuity with the mucous membrane of the throat, through the Eustachian tube. Extremely delicate, and in some parts very vascular, it is not merely a mucous membrane, but is theoretically a combination of periosteum and mucous membrane, being what Bichat called fibro-mucous. It invests all the elevations and depressions observed on the walls of the tympanum, and extends into the mastoid cells. The outer layer of the membrane of the fenestra rotunda, *membrana tympani secundaria*, is a continuation of it.

The base of the stapes is fixed by its circumference to the outer edge of the groove, which encircles the vestibular fenestra, by a membrane or ligament. The lining membrane of the vestibule, continued over the base of the stapes from within, also invests the inner surface of this annular ligament, whilst the outer surface of it is covered by the membrane lining the tympanum as it is reflected on the stapes.

The membrane lining the tympanum invests the small bones and the tendons of their muscles where they run free in the cavity. A fold of it fills up the space bounded by the crura and base of the stapes. The chorda tympani, also, in its passage across the tympanum, is enveloped by it. Lastly, it forms the inner borrowed layer of the membrana tympani, covering and adhering closely to the handle of the malleus.

The Eustachian tube, (tuba Eustachii, s. canalis palatinus tympani; Fr. *la trompe d'Eustachi;* Germ. *die Eustachische Röhre oder der Gaumengang des mittleren Ohrs.)* — The Eustachian tube is a passage of communication betwixt the cavity of the tympanum and the throat. In length about an inch and a half, it is directed from behind forwards, from without inwards, and from above downwards. Its guttural orifice is wider than that by which it opens into the tympanum.

Proceeding from the tympanum, its first part is an osseous canal, *the osseous part of the Eustachian tube;* the walls of the remainder of it are composed partly of cartilage, partly of fibrous membrane, *the cartilaginous and membraneous portion of the Eustachian tube.*

The osseous part of the Eustachian tube, *pars ossea tubæ Eustachii,* begins at the anterior and lower part of the tympanum, by a funnel-like orifice, and runs forwards and inwards on the outside of the carotid canal, and below that for the reception of the internal muscle of the malleus. It is about half an inch in length, and ends by a notched and irregular edge at the reentering angle, between the squamous and petrous portions of the temporal bone. Its calibre contracts in its course forwards, and is compressed from without and below inwards

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les organes qui tendent ou relachent la mem-
du tympan et la chaine des osselets de l'ouie
l'homme et les animaux mammifères. In
l de Physiologie experimentale, t. 1., p.
Paris, 1821.

ber ein linsenförmiges Knöchelchen im
lus Stapedius mehrerer Säugethiere. In
r's Archiv. Jahrg. 1838.

itrage zur pathologischen Anatomie des
organs, in the Medicin. Jahrbücher des
oestr. Staates. Wien 1836. Bd. xx. p.

[*] Vindiciæ quorundam inventorum anat. in dubium

and upwards. In the dry bone it is wide enough to admit the end of a quill stripped of its feathery part, about one-twelfth of an inch thick. In the recent state, when lined by its mucous membrane, it is very much narrower.

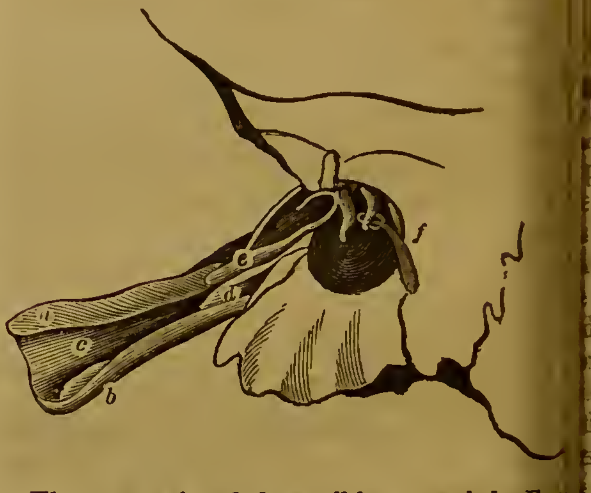
The cartilaginous and membraneous portion of the Eustachian tube, pars cartilaginea et membranacea tubæ Eustachii.—In the skull it is observed that the osseous part of the Eustachian tube is continuous with a sort of gutter which is formed by the outer and anterior side of the petrous bone, and the posterior inner and lower margin of the great wing of the sphenoid bone. To this gutter the external wall of that part of the Eustachian tube under consideration, which is partly cartilaginous and partly fibro-membraneous, corresponds at its tympanic extremity; towards the guttural orifice of the tube, the membraneous wall is applied against the circumflex muscle of the palate. The inner, and also the upper wall of this portion of the Eustachian tube, is formed of a grooved cartilaginous lamina of a triangular form, fixed by dense cellular tissue to the irregular extremity of the osseous portion, to the apex of the petrous bone, and to the root of the inner plate of the pterygoid process of the sphenoid. At the guttural orifice of the Eustachian tube, it forms a semilunar prominence with its convexity turned upwards and backwards. The cartilaginous plate of the outer wall does not extend to the mouth of the tube, but only fills up that place where the outer wall of the bony groove above-mentioned as continuous with the osseous part of the Eustachian tube is defective, that is, from before the foramen spinosum of the sphenoid to the scaphoid fossa at the root of the inner plate of the pterygoid process.

The cartilaginous and membraneous portion of the Eustachian tube is about one inch long. Being compressed from within outwards, a section of it is an elliptical fissure. From its junction with the osseous portion, it goes on widening, so that the point of junction is the narrowest part of the tube;—in the recent state, about one-thirtieth of an inch in diameter, just sufficient to admit a small probe.

The mouth of the Eustachian tube in the throat forms an oval-shaped fissure, about three-eighths of an inch long, bounded anteriorly and posteriorly by prominent swollen edges. The fissure is directed obliquely from above downwards, and from before backwards, and is situated at the upper and lateral part of the pharynx behind the soft palate. In reference to the nasal passage, my observation agrees with that of Kramer,* that the *lower angle* of the guttural orifice of the Eustachian tube *lies a very little deeper* than the *horizontal line of the lowest meatus*, whilst *the upper angle is a little deeper than the horizontal line of the middle meatus.*

The Eustachian tube is essentially a tegumentary canal; through it atmospherical air is admitted into the tympanum, a condition which, by keeping up an equable pressure on either side of the membrana tympani, and giving free scope to the play of the small bones upon eac other, is necessary for the perfect exercise o hearing. Its lining membrane is continuou with that of the throat on the one hand, an with that of the tympanum on the other At the guttural orifice of the tube, it has all th properties of the mucous membrane of th nose and throat; as it approaches the tym-num it becomes thinner and finer, until assumes all the characters of the fibro-muco lining of the tympanum. Within the osseo portion of the tube, it no longer presents any o the mucous glands which are found in the mucous membrane of the prominent edges of the guttural orifice, and in that lining the ca-laginous and membraneous portion—mu glands, which perform so important a part the economy, and particularly the morbid states of the Eustachian tube and apparatus of hearing generally.

Fig. 21.



The two muscles of the small bones, and the Eust chian tube. (From Soemmerring.)

a. b. c. d. Eustachian tube; e. muscle of the ma leus; f. the muscle of the stapes.

2. *The external ear, including the auditory passage.*

A. The auricle or the ear, (auricula s. p na,) Fr. *pavillon de l'oreille;* Germ. *das Ohr.* The human auricle, as is known, presents the surface directed outwards, prominenc bounding gutter-like depressions, which w like a maze in different directions; but all le at last into the auditory passage. Considere in a general way, the surface directed outwar is concave. The surface turned towards t side of the head is, on the contrary, genera speaking, convex, but it is depressed at t places corresponding to the elevations on t outer surface, and more elevated where the d pressions are.

The hem-like fold of the edge of the ear round is called *helix.* The eminence wi the helix is called *anthelix,* and the gutter-li depression between the two is called the *na cular fossa.* At its upper extremity the an lix divides into two branches, between which a triangular depression called *fossa innomina* The lower extremity of the anthelix runs i a projection called *antitragus,* opposite whi and under the anterior part of the helix, is broad projecting plate called *tragus,* whi valve. The posterior margin of the and anterior margin of the antitragus, feriorly; but superiorly they are sepay a considerable notch. Bounded by elix, tragus, and antitragus, and traorizontally by the commencement of the ; a deep cavity, called *concha*, at the anart of which is the auditory passage from it, as the pipe from the mouth of a The lower pendulous part of the ear is *bule.*

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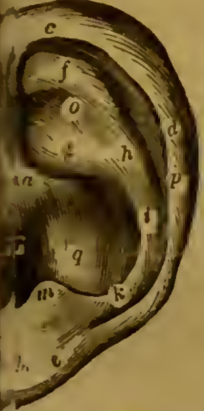
* Die Erkenntniss und Heilung der Ohrenkrank-

Fig. 22.



a. b. c. d. e. the helix; *f. g.* the upper and lower crura of the anthelix; *h.* the point of junction of the two crura; *i. k.* the anthelix; *l.* tragus; *m.* antitragus; *n.* lobule; *o.* navicular fossa; *p.* fossa innominata; *q.* cavity of the concha; *r.* entrance of the auditory passage.

uricle of the left side (reduced in size). (From ring.)

ped of the skin which invests it, the is found to be composed of a cartilaskeleton, on which its elasticity depends. eleton presents, with some modifications, eminences and depressions we have de-, except the lobule, which consists merely olonged fold of skin, between the layers ch is cellular and adipose tissue.

e skeleton of the auricle, the *helix* com- ; by an acute point in the excavation concha. Gradually becoming broader ore elevated, it proceeds obliquely upand forwards, then turning round the margin of the ear, contracts in breadth; out the middle of the posterior margin, like fold having ceased, its simple edge inued into a free tail-like process of carwhich is separated by a fissure from the gus. On the anterior part of the helix the tragus, there is a mammillary process ilage which gives attachment to a liga- Behind and below the root of this illary process, there is a small vertical in the helix, *incisura helicis.*

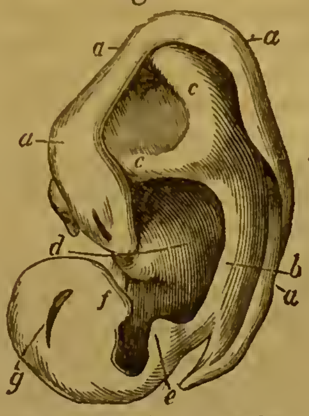
garding the *anthelix* there is little more to d, except that the lower branch of its extremity forms a very prominent crest; at inferiorly the anthelix is continued into me tail-like process that the helix runs nd is also partly continued into the anti-.

e *antitragus* is a small plate of cartilage, ng an angle, directed upwards and forwards. continuous by its base with the cartilage e concha. The lobule hangs from the agus, and the tail-like process of cartilage non to the helix and anthelix.

ugus.—Between the helix and tragus there connexion by cartilage. The space is ly filled by a continuation of the fibrous lar tissue which constitutes the upper and rior part of the cartilaginous and mem-

The cartilage of the ear is covered by perichondrium, which imparts considerable strength to it. When the perichondrium is removed by dissection, the cartilage is found to be very brittle.

Fig. 23.



a. a. a. a. helix; *b.* anthelix; *c.* two crura of anthelix; *d.* cavity of the concha; *e.* antitragus; *f.* tragus; *g.* fissure between the tragus and commencement of cartilaginous portion of the auditory passage, the larger fissure of Santorini.

Skeleton of the cartilage of the external ear (diminished). (From Soemmerring.)

The skin covering the cartilage of the ear adheres intimately to its unequal surface, less so to its back and circumference. The lower part of the hem-like fold of the helix is formed entirely by it; also the lobule, as has been already said. The skin of the auricle contains a number of sebaceous follicles, particularly in the concha, and around the entrance of the auditory passage.

On the tragus is observed, especially in old people, a small tuft of hair, which has been compared to a goat's beard; whence the name tragus,(τϱαγος, hircus,) which the Germans translate *Bock.* The *antitragus* they call *Gegenbock.*

Ligaments of the ear. Anterior ligament, (ligamentum auriculæ anterius).—This proceeds from the root of the zygomatic process to the lower and anterior part of the helix, and to the tragus.

Posterior ligament, (ligamentum auriculæ posterius).—Extends from the outer surface of the mastoid process to the posterior surface of the cartilage of the ear, where the concha runs into the auditory passage. Besides the above ligaments binding the ear to the head, there are others which extend from one point of the cartilage of the ear to another.

Muscles of the ear.—The muscles of the ear fall into two classes: viz. those which, arising from the head, are inserted into the ear, and move it as a whole; and those which, extending from one part of the cartilage to another, are calculated, were they strong enough, to produce a change in the general form of the auricle.

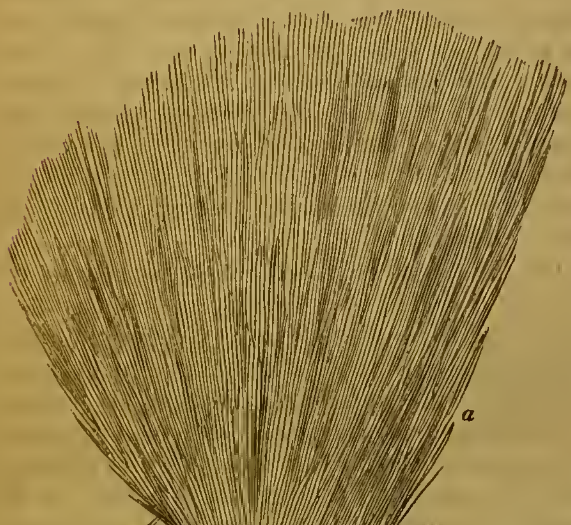
Muscles which move the ear as a whole, or the extrinsic muscles.—The elevator, or superior muscle of the ear, (M. attollens auriculam s. superior auriculæ), is a broad thin muscle, composed of fibres spread out on the upper part of the side of the head. It arises from the middle part of the epicranial aponeuroses, and also from the temporal aponeuroses; thence, to its insertion into that elevation of the ear-cartilage on the surface next the head, which corresponds to the fossa innominata, the fibres become more aggregated, so that the muscle is much narrower, but thicker inferiorly than suear, it will widen and straighten the auditory passage.

The retractor or posterior muscles of the ear, (M. retrahentes auriculam, s. posteriores auriculæ.) These ordinarily consist of three bundles, sometimes only two, which, taking their origin from the mastoid process, run forwards to the cartilage of the ear, into which they are inserted at the eminence on the back of the concha, corresponding to the commencement of the helix on the other side.

In drawing the ear backwards, these muscles will dilate and flatten the concha, and widen the entrance to the auditory passage.

The anterior muscle of the ear, (M. attrahens auriculam s. anterior auriculæ,) arises from the zygomatic process, and, in its course backwards to the ear, gradually contracts, until it ends in a short tendon, which is inserted into the anterior surface of the helix, immediately above the tragus. It draws the ear forwards.

Fig. 24.



The cartilage of the left auricle from behind, and the extrinsic muscles (diminished). (From Soemmerring).

a. m. attollens auriculam; *b.* m. anterior auriculæ; *c. d.* two m. retrahentes auriculam.

Intrinsic muscles of the ear.—These muscles are very delicate and weak, little adapted to produce any sensible change in the form of the ear. Five are admitted:—

The larger muscle of the helix, (M. helicis major,) arises from the lower and anterior part of the helix, on the outer and anterior surface of which it ascends for about three quarters of an inch, and then is inserted into the helix above the point where the ear becomes free from its attachment to the head.

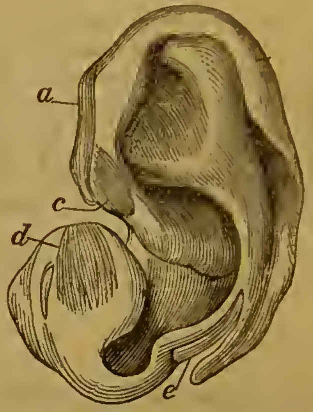
The smaller muscle of the helix, (M. helicis minor.)—This lies farther down and more be-

where the helix rises from the concha, an inserted into the posterior margin of the asce ing portion of the helix.

The muscle of the tragus, (m. tragicus).— an oblong square form, this muscle covers outer surface of the tragus, from the lower to the upper margin of which its fibres run.

The muscle of the antitragus, (m. antitr cus).—The fibres of this muscle arise from outer surface of the antitragus, and are inser by a small tendon to which they converge the lower extremity of the anthelix.

Fig. 25.

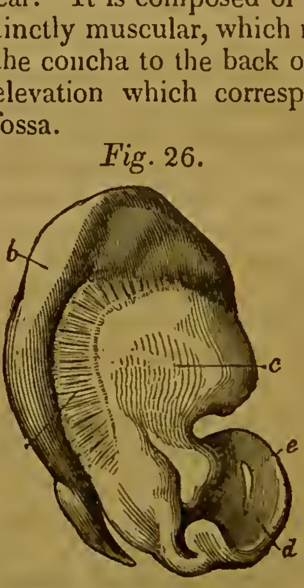


a. m. helicis ma
c. m. helicis mi
d. m. tragicus; *e.*
antitragicus.

The intrinsic muscles situated on the concave the auricle (diminished). (From Soemmerring).

The transverse muscle of the ear, (m. tr versus auriculæ,) is situated on the back of ear. It is composed of fasciculi not very tinctly muscular, which run from the dorsu the concha to the back of the anthelix, and elevation which corresponds to the navic fossa.

Fig. 26.



a. transversus
cle; *b.* helix; *c.*
of the concha; *d*
gus; *e.* fissure of
torini.

The back of the cartilage of the external ea the transversus muscle (diminished). (From Soem ring).

B. *The external auditory passage, (meatu ditorius externus s. porus acusticus;* Fr. *Lc duit auditif ou auriculaire;* Germ. *Der G gang.)*—Like the Eustachian tube, the ext auditory passage is composed of an os portion, and a portion partly cartilaginous partly membraneous. The osseous portio been already described as a part of the wall of the tympanum; the other portion c to be noticed here as a continuation of the tilage of the auricle. The passage will th considered as a whole.

Cartilaginous and membranous porti the external auditory passage, *meatus audi cartilagineus-membranaceus.* This porti the auditory passage, about half an inch lo

...... by dense fibro-membraneous cellu-
ue, in which many ceruminous glands are
led.

plate of cartilage which forms the an-
and lower wall of this portion of the
ry passage is of a triangular shape with a
running through its base to near the apex.
ise is below; the apex above. The base
ponds to the anterior surface of the mas-
process. One side is attached to the
r and lower part of the circumference
outer extremity of the osseous passage,
se and strong cellular tissue. The other
orresponds to the base of the tragus.
pex or angle formed by the two sides
nto the upper part of the base of the
and corresponds to the root of the
atic process. The angle formed by the
and that side which is attached to the
s part of the passage, is extended into
d pointed tongue, which is fixed into the
nd rough depression at the lowest part
margin of the orifice of the osseous
e. The angle formed by the base and
ier side is continued into the concha.

dense fibrous cellular tissue, which
etes the passage above and behind, ex-
from the cartilage of the concha to the
and posterior part of the margin of the
al orifice of the osseous part of the passage.
at are called the fissures of Santorini,
ræ Santorinianæ, are:—1. that fissure
ling through the base of the triangular
of cartilage to near its apex; and 2. that
en the outer margin of the cartilage and
ase of the tragus. These fissures are
by fibrous cellular tissue which, particu-
ver the second fissure, appeared to San-
to consist of muscular fibres. These
have, therefore, received the name of the
e of the largest fissure, or the muscle of
rini, *m. incisuræ majoris s. Santorini.*
considered their action to be, by ap-
nating the cartilaginous pieces, to shorten
ngth of the passage.

wed as a whole, the auditory passage is a
of an oval calibre. It leads from the
e to the tympanum, from the cavity of
it is separated by the interposition of the
rana tympani. In front of it lies the
of the lower jaw, behind is the mastoid
ss. In the adult its length is about an inch
quarter, and its direction is at first some-
forwards, then upwards and backwards,
astly downwards and forwards again. Its
wall is from one-tenth to one-fifth of an
longer than the upper.

e auditory passage is lined by a continua-
of the skin of the auricle. This skin be-
more and more delicate as it approaches
ous part of the passage,—extremely so
it is continued on the outer surface of
mbrana tympani. The skin of the audi-
passage is covered with fine hairs, and in
ons close to the entrance, hairs like
e on the tragus, sometimes of considerable
th, are enrooted.

he skin of the auditory passage is connected
ie subjacent cartilage and bone by rather
tissue and sparing cellular tissue. The epider-
mis readily separates by putrefaction, and may be drawn out like the finger of a glove, the blind end being the part which forms the outer borrowed layer of the membrana tympani.

From about a tenth of an inch within the auditory passage to about one-fifth of an inch from the membrana tympani, the lining integument is perforated by numerous small apertures, the terminations of the excretory ducts of the glands which secrete the ear-wax. These excretory orifices are most numerous about the middle of the passage, towards the termination of the cartilaginous and membraneous portion.

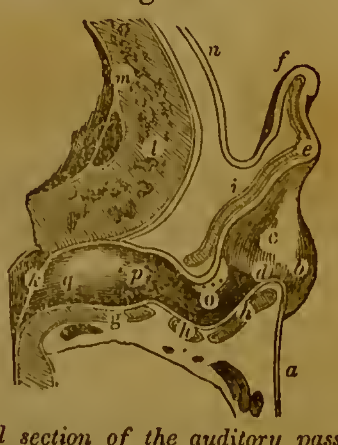
The ceruminous glands, *glandulæ ceruminosæ*, are small round or oval bodies of a brownish yellow colour, and very vascular. They are imbedded in the areolæ presented by the dense cellular tissue which connects the skin of the auditory passage to the subjacent cartilage or bone.

The ear-wax, *cerumen*, is, as is known, a thick orange-coloured or yellowish brown viscid substance, of an extremely bitter taste, and somewhat aromatic odour. When first secreted, it is a thin yellowish milky fluid. (See CERUMEN.)

The auditory passage, especially in the middle, is usually covered with a more or less thick layer of it. It consists principally of a butter-like fat and albumen in combination with a peculiar animal matter; of a yellow, bitter, alcoholic extractive matter, with lactate of potass and lime and a watery extractive matter.

In irritation or diseased states of the glands, the ear-wax is changed in its properties, and is thrown out in larger quantities than usual, so that it collects and comes sometimes to fill completely the auditory passage, and thus give rise to dulness of hearing.

Fig. 27.



Horizontal section of the auditory passage (diminished). (From Soemmerring).

a. Skin of the face in front of the ear; *b.* lobule of the auricle; *c.* the antitragus; *d.* the tragus cut; *e.* anthelix; *f.* helix; *g.* anterior part of the osseous auditory passage, cut; *h, h.* anterior part of the cartilaginous portion of the passage, cut; *i.* posterior part of the cartilage of the ear; *k.* membrana tympani; *l.* section of the mastoid process; *m.* dura mater; *n.* skin behind the ear. It is seen continued over the auricle, and from that into the auditory passage; *o.* first or greater curve of the auditory passage; the end of which is directed forwards; *p.* the second or smaller curve, directed backwards; *q.* third and smallest curve; at *o.* and *p.* are seen the orifices of the ceruminous glands.

Nerves of the accessory parts of the apparatus of hearing.

Nerves of the tympanum.—The tympanum receives nerves from different sources—from the fifth, the seventh, eighth, and ninth pairs of cerebral nerves. Moreover, its nerves have communication with the sympathetic system.

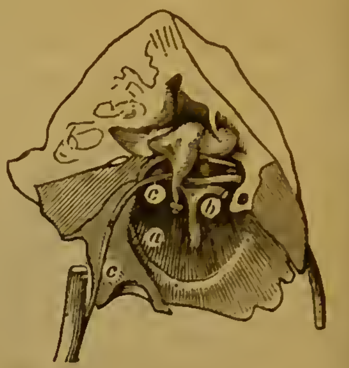
The facial nerve or portio dura of the seventh pair rises from the brain by two roots, which unite together in the meatus auditorius internus, but before uniting, the smaller root sends off a delicate filament, which forms a communication, as has been mentioned, with the auditory nerve. This communication, first pointed out by Swan, has recently been very fully investigated by Arnold. According to the latter, in the middle or at the bottom of the internal auditory meatus, one or several delicate filaments go off from the smaller branch of the facial, and join the auditory nerve. After this the facial nerve enters the aqueduct of Fallopius, and issues from the cranium through the stylo-mastoid hole. In this course it receives, at the place where it forms the knee-like bend into the aqueduct of Fallopius, the superior branch of the Vidian or superficial petrosal nerve, *nervus petrosus superficialis, s. major.*

The superficial petrosal nerve comes off, along with the inferior branch of the Vidian or deep petrosal nerve, from the posterior part of the spheno-palatine ganglion or ganglion of Meckel. Leaving the deep petrosal nerve at the posterior orifice of the Vidian canal, the superficial petrosal proceeds upwards through the cartilaginous substance in the foramen lacerum medium, and then runs backwards in the groove on the anterior surface of the petrous bone leading to the hiatus of Fallopius. Having entered the latter, it joins the facial nerve, and forms, with its external fasciculi, a gangliform swelling, *intumescentia gangliformis nervi facialis*, of a grayish appearance and soft consistence.

From this swelling a filament arises by one or two roots, and runs backwards into the internal auditory passage to join the upper portion of the auditory nerve, where the first filament joined, and forms with it a small reddish gray elevation, known to and delineated by Scarpa.

Another branch, which arises from the ganglionic swelling, is the *chorda tympani.* The chorda tympani thus in reality derives its origin both from the facial and the superficial petrosal nerves. The chorda tympani accompanies the facial nerve along the aqueduct of Fallopius till within a little of the exit of the latter by the stylo-mastoid hole. The chorda tympani then leaves the facial nerve at an acute angle, and proceeds upwards in a proper canal in the bone, enters the cavity of the tympanum by the opening just within the posterior part of the groove for the membrana tympani already described. From this opening it proceeds forwards between the long process of the incus and the handle of the malleus, to the fissure of Glasser, through the canal beside which, already described, it makes its exit from the cavity of the tympanum. It then descends by the inner side of the ascending ramus of the lower jaw and joins at an acute angle the lingual nerv In its passage across the cavity of the tympa num, the chorda tympani anastomoses by on or several filaments with the nerve which th fifth pair sends to the membrana tympani.

Fig. 28.



The membrana tympani from within, and the co of the chorda tympani across the tympanum, togeth with the connexions of the malleus and incus (mag fied). (From Soemmerring).

a. Membrana tympani; *b*. handle of the malle and tendon of the internus mallei cut near its sertion; *c, c*. the chorda tympani.

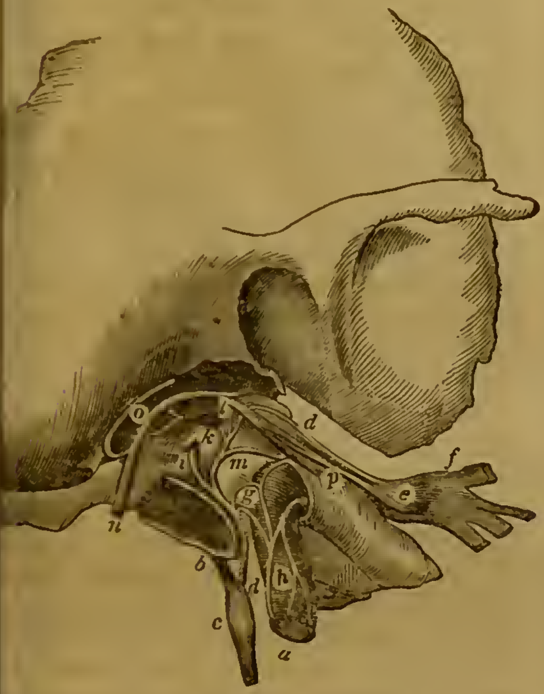
To return to the facial nerve. It gives o a little below the pyramid, a branch to the s pedius muscle.

The *pneumogastric nerve*, in its passa through the base of the skull, forms a sm ganglion, from which springs a nerve wh goes to the ear, *ramus auricularis nervi va* This nerve is joined by a filament from t petrous ganglion of the glosso-pharyngeal; then runs, according to Arnold, in a groove the jugular fossa, and at last arrives at aqueduct of Fallopius. Here it divides three branches, the smallest of which runs wards in the aqueduct of Fallopius towa the origin of the facial nerve, and unites it; the second branch, which is somew larger, runs downwards, and also anastom with the facial. The third and most consid ble branch will be noticed along with nerves of the auricle and auditory passage.

The nervous anastomosis in the tympanu The principal nerve of this anastomosis is nerve of Jacobson, or tympanic nerve of Arn

The tympanic nerve, *nervus tympanicus*, tends between the petrous ganglion of the glo pharyngeal nerve and the otic ganglion or g glion of Arnold. To follow it from the glo pharyngeal, we find it arises from the u part of the petrous ganglion, along with ano filament, which goes to communicate with *ganglion cervicale supremum*, and also with pneumogastric. The tympanic nerve en by the tympanic canal already described, cavity of the tympanum. Here the nerve pears near the anterior margin of the fen rotunda, traverses the groove on the pro tory, arrives in front of the vestibular fen then enters the proper osseous canal, into wl the groove on the promontory is continued y, and which opens on the surface of the s bone outside, and in front of the hiatus lopius. From this the nerve advances n the anterior margin of the petrous nd the posterior angle of the great wing sphenoid, between the internal muscle malleus and the superficial petrosal There it approaches the nerve of the is mallei, and proceeds parallel with it, ider the name of *nervus petrosus superficialis minor Arnoldi,** goes to join the otic n.

Fig. 29.



us plexus of the tympanum (from Breschet.)

ternal carotid artery; *b.* glosso-pharyngeal c. petrous ganglion of the same nerve; principal trunk of the nervous plexus of the num which extends to join, *e.* the otic gang- r ganglion of Arnold; *f.* lower maxillary o which the ganglion adheres; *g.* filaments munication between the nerve of Jacobson e carotid plexus; *h.* carotid plexus; *i.* fila- o the fenestra rotunda, or cochlear fenestra; ent to the vestibular fenestra; *l.* filament o anastomose with the facial nerve; *m.* fila- running alongside the Eustachian tube; tio dura of the seventh pair; *o.* chorda tym- ut; *p.* nervous filament from the otic gang- the muscle of the malleus.

e branches given off and the communica- formed by the tympanic nerve in the course ibed, are the following. On entering the anum, the tympanic nerve divides into branches, a lower and an upper. The branch first gives twigs to the Eustachian and then passes out of the cavity of the anum into the carotid canal, through a passage in the bone, where it anastomoses with the sympathetic nerve. The upper branch, the continuation of the nerve, gives a twig to the secondary membrana tympani. According to Varrentrapp, there arises from it, by two roots, a twig which runs on the inner wall of the cavity of the tympanum, then into the Eustachian tube, the cartilage of which it penetrates anteriorly, and at last loses itself in the mucous glands around its guttural orifice. A little higher up a third branch goes to the vestibular fenestra, and, according to Lauth, the tympanic nerve receives, immediately on its entrance into the canal in the upper part of the petrous bone, a filament from the facial nerve. Moreover, the tympanic nerve receives a filament of communication from the external branch of the *nervus caroticus,* the anterior and stronger branch of the first cervical ganglion of the sympathetic.

From the otic ganglion a nerve goes to the internal muscle of the malleus, *ramus ad tensorem tympani.* It arises from the upper and posterior part of the ganglion, and runs backwards on the inner side of the middle meningeal artery to the muscle.

2. *Nerves of the auricle and auditory passage.*—The auricle and auditory passage derive their nerves from the cervical plexus, from the facial, from the third branch of the fifth pair, and also from the pneumogastric.

The nerve from the cervical plexus is the great auricular nerve, *nervus auricularis magnus.* It comes off from the anterior branch of the third cervical nerve, and is distributed principally to the skin on the back of the auricle and to the posterior muscles. One branch passes between the antitragus and the tail-like process of the helix to the other surface of the ear and ramifies there.

The *facial nerve* on its exit from the stylomastoid hole gives off the posterior, inferior or deep auricular nerve, *nervus auricularis posterior, profundus inferior,* which receives a twig from the pneumogastric and another from the great auricular branch of the third cervical and then divides into two branches, a posterior larger, and an anterior smaller. The former gives twigs to the skin of the mastoid process and the retrahentes auriculam muscles, the latter spreads on the lower and posterior part of the cartilaginous auditory passage and the concha, giving twigs to the skin of these parts and the retrahentes auriculam. It sometimes sends a branch through the cartilage into the auditory passage to ramify in the integument lining that part.

The temporal branches of the facial nerve send filaments to the skin of the anterior part of the auricle, and to its anterior and superior muscles.

The superficial temporal nerve, a branch of the posterior and inferior fasciculus of the third division of the fifth pair, gives off two branches, *nervi meatus auditorii externi, inferior et superior,* the ramifications of which are distributed to the integument of the auditory passage and concha. There is one branch, *nervus tympani,* which runs under the upper wall of the osseous

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Pidder (Neurologische Beobachtungen. Dor- 1836,) has recently discovered a new nervus sus superficialis, which, for the sake of distinc- he calls *tertius.* It proceeds from the plexus npanying the middle meningeal artery into the y of the cranium, passes through a proper fis- in the anterior surface of the petrous bone and the entrance of the canal of Fallopius into etrous bone to join the facial. It is not always nt.

auditory passage to the membrana tympani, between the layers of which it glides and separates into very delicate filaments, by one or two of which it anastomoses with the chorda tympani. The last branch of the superficial temporal nerve sends filaments to the auricle and its anterior and superior muscles.

The third and most considerable branch of the auricular nerve of the pneumogastric, *ramus auricularis nervi vagi*, gets into the *canaliculus mastoideus* of Arnold, through an opening near the lower aperture of the *canalis chordæ tympani*. It here divides into two branches, one of which joins, as has been said, the posterior auricular branch of the facial nerve; the other, which is stronger, arrives at the posterior wall of the external auditory passage, gives filaments to the ceruminous glands, and in company with a branch of the posterior auricular artery penetrates the cartilage of the ear to ramify on the skin covering its convex surface.

Arteries of the external ear and tympanum. The *posterior auricular artery*. This supplies branches which ramify on the convex surface of the auricle, and also turn over the helix to spread out on the other surface. Twigs are also given off to the auditory passage.

A remarkable branch of the posterior auricular is the *stylo-mastoid artery*. This enters the stylo-mastoid hole and runs along the aqueduct of Fallopius, and ends by anastomosing with a branch of the middle meningeal, called the Vidian artery, which enters by the hiatus of Fallopius. In its course the stylo-mastoid artery transmits twigs to the mastoid cells, the external auditory passage, the membrana tympani, the stapedius muscle, and the external semicircular canal.

The twig to the membrana tympani is called *arteria tympanica superior*. This artery, together with the *arteria tympanica inferior* from the internal maxillary, supplies the membrana tympani. The arteries run round the circumference of the membrane and down along the handle of the malleus, and branching out form by their inosculations a fine net-work.

The *temporal artery* sends branches to the anterior part of the auricle, the external auditory passage, and to the ceruminous glands. It also gives off a branch which enters the tympanum by the fissure of Glasser, and ramifies in the mucous membrane of the outer wall of that cavity.

The *occipital artery* gives twigs to the auricle.

The *internal maxillary artery*.—This artery gives off a branch to the joint of the lower jaw, a twig of which, the *arteria tympanica inferior*, just mentioned, passes through the fissure of Glasser into the tympanum and inosculates on the membrana tympani with the twigs of the superior tympanic artery of the stylo-mastoid. The internal maxillary also sends a branch, the deep auricular artery, *arteria auricularis profunda*, to the cartilaginous portion of the auditory passage, where it supplies the lining integument and glands. It moreover sometimes gives small branches to the Eustachian tube.

The *middle meningeal artery* in the first part of its course gives branches to the Eustachian tube. In the cranium it sends a branch, *arteri* *Vidiana*, into the Fallopian canal, which h been already described as anastomosing wit the stylo-mastoid. It also sends branches the tympanum, which ramify in the mucou membrane of that cavity and in the muscles the small bones.

The *accessory middle meningeal artery*, wh present, gives branches to the Eustachian tub The *inferior pharyngeal artery* also giv branches to the Eustachian tube, to the pyra and cavity of the tympanum. The Eustach tube also receives twigs from the *inferior p* *tine branch of the facial artery*.

The internal carotid, before entering cranium, sometimes gives a small twig to Eustachian tube and sends another, throu small passage leading from the carotid ca into the tympanum, to the promontory.

In some animals, such as the mole, t squirrel, the guinea-pig, the marmot, &c. t is an osseous canal like a bar of bone extend over the vestibular fenestra and running thro between the crura of the stapes. This w first observed by Sir Anthony Carlisle in t marmot and guinea-pig, who describes it "an osseous bolt to rivet it (the stapes) to situation."* The canal is for the passage of artery and nerve which in some other anim are unprovided with an osseous canal in th course through the stapes. The artery runn through the stapes was observed about t years ago by Professor Otto† in hybernati animals; but Professor Hyrtl of Prague‡ shewn that the artery is by no means pecul to those animals, as it does not occur in and as it occurs in animals which do not hyb nate.

Mr. Shrapnell§ describes in the human an artery accompanied by a nerve, pas through the membrane which fills up the sp between the arms of the stapes. Mr. Shrap was led to this observation from what he seen in the rat, viz. a nerve and artery pas through the stapes and supported by a min channel of bone. Professor Hyrtl|| has m recently described three modes of distribu of the arteries in man, which he has met w analogous to the artery running through stapes in the animals above mentioned.

The arteries of the external and middle are accompanied by corresponding veins. to lymphatics, there are some small gla behind the auricle and in front of the mas process. The lymphatic vessels of the exte ear accompany the arteries and veins, but p cipally the latter. Little or nothing is kn of the lymphatics of the tympanum.

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* On the Physiology of the Stapes in Philos Trans. 1805, p. 204.

† Nova Acta Acad. Cæs. Leop., tom. p. 662.

‡ Ueber die Analogien der durch den Steigb verlaufenden Arterie, &c. in Medicinische J bücher des oesterreichischen Staates, Bd. p. 457, Wien 1836.

§ On the Nerves of the Ear, in London Me Gazette, vol. x. p. 507, 1832.

|| Loc. cit.

III.

lopment and irregular conditions of the organ of hearing.

evelopment and irregular conditions of
bulb.—Our knowledge of the early for-
of the ear-bulb is not very precise. This
ve know, that it has quite a separate
rom the rest of the apparatus of hearing.
in the irregular conditions of the organ
ing on defective development, there is
tant and necessary relation betwixt the
h and the accessory parts of the ear;
atter may be imperfect while the former
natural state, and *vice versâ.* In many
iowever, it has been found that imper-
elopment of the one attended an irre-
ondition of the other. The earlier a
formed the fewer deviations it is subject
greater number of malformations affect
essory parts than the ear-bulb, as the
are developed subsequent to the latter.

development of the ear-bulb commences
rly, soon after the appearance of the
t takes place by the springing forth of
litory nerve in the form of a tubular
ation of the brain. At its central ex-
the cavity of the cerebral prolongation
nuous with that of the fourth ventricle.
ripheral extremity, which extends into
scular layer of the embryo, and particu-
nto the osseous part of it, forms a vesi-
dilatation which is gradually separated
he brain. To this vesicle of nervous
nce, which is the labyrinth, there grows
ls a reflection of the tegumentary layer to
ie accessory parts of the organ of hearing.
h is Baer's account of the development
ear in the chick. Huschke, on the con-
ays that the membraneous labyrinth does
ise from the brain, but is originally a
sac of the skin with an excretory duct,
gradually contracts, until the blind sac
n is completely cut off from the rest of
umentary system.

vever this may be, the labyrinth, accord-
the observations of Valentin* made on
nbryo of the sheep, exists at a very early
, under the form of a simple elongated
vith an oblong cavity, which is the ves-
. This cavity becomes broader, assumes
ider form, and presents in the interior a
what uneven surface. Soon after this, its
end is elongated and begins to make a
ar turn, which is the first rudiment of the
ea. The turns of this cochlear vesicle be-
gradually more developed. A short time
the commencement of the development of
ochlea, the semicircular canals begin to
themselves as processes or diverticula of
estibule. There first appears the posterior
and behind the vestibular fenestra; it be-
s elongated from within and below out-
s and upwards, then bending in the form
arch returns to the vestibule. In a si-
r manner the superior and inferior semi-
lar canals are formed. The semicircular canals are at first proportionally very wide, but gradually contract, till at last the ampullæ present the only trace of their former width. The vestibule itself has diminished in breadth and length, and acquired a more trapezoidal form. The vestibular fenestra, which was before not very distinct and still round, has become more evident and exhibits an oval shape.

What Valentin here describes is only the basis of the future osseous labyrinth. There exist as yet no observations bearing on the mode of development of the membraneous labyrinth.

The irregular conditions which the labyrinth has been found to present, as well as the structure permanent in the lower animals, correspond in a remarkable manner with the above-described stages of development. Thus in a monstrous fœtus, Hyrtl* found, instead of a vestibule, cochlea, semicircular canals, and internal meatus, a single very capacious cavity, containing a membraneous sac, in which the auditory nerve, sufficiently well developed, terminated. There was no trace of vestibular or cochlear fenestra, and the accessory parts of the organ were entirely wanting. Röderer† describes a somewhat similar case, in which, however, some of the accessory parts presented themselves, though in a very rudimentary and imperfect form.

The cochlea has presented itself as a mere subdivision of the vestibule without any windings, a state of parts which is permanent in birds. In other cases, though presenting windings, these have been found fewer than natural, and sometimes the spiral lamina has been wanting or not extending throughout all the turns of the cochlea, so that no subdivision into scalæ or but a very imperfect one presented itself. The semicircular canals are sometimes smaller and narrower than usual; one or all of them have been found wanting or but partially present. In the latter case, after running a short way, they have been observed stopping short and terminating in a cul-de-sac. The semicircular canals, as they are formed later, more frequently present deviations from the regular structure than the vestibule and cochlea.

Our knowledge of the ear-bulb in the human embryo commences at about the third month, when the membraneous labyrinth is already very perfectly developed and surrounded by a cartilaginous shell, having a structure as complicated as at a more advanced period the bony shell presents. The membraneous labyrinth is at this early period so firm that it is not very difficult, by means of careful dissection and manipulation, to extract the whole from its cartilaginous case.

According to Meckel,‡ the membraneous labyrinth is composed at first of two perfectly

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Handbuch der Entwickelungsgeschichte des
chen, p. 206.

* Beiträge zur pathologischen Anatomie des Gehörorgans. In the Medicinische Jahrbücher, des k. k. oestr. Staates. Wien, 1836. Bd. xx. p. 446.

† Descriptio fœtus parasitici. In Commentariis Soc. reg. Gœttingensis. tom. iv. 1754, pp. 136—148.

‡ Manuel d'Anatomie, etc. traduit par Jourdan et Breschet, tome iii. s. 1948—30 Paris, 1825.

distinct membranes, the one simply inclosed within the other, but not connected farther. The inner membrane is thinner but firmer and more elastic than the outer. The latter, which does not adhere to the cartilaginous case any more than it does to the osseous labyrinth which succeeds it, gradually becomes thin, until at the seventh month there is no longer any trace of it. The inner membrane, on the contrary, becomes proportionally thicker and firmer.

Meckel has never found the membraneous labyrinth in a more simple form, nor has he been able to determine whether it ever exists naked in the cranium.

At a very early period the pulpy mass of the auditory nerve becomes converted into nervous bundles, and grows either by lateral additions or by an increase of its filaments. The cochlear part of it, according to Valentin,[*] lies free in the tube of the cochlea under the form of a thick white cord; it follows the turns of the cochlea, but gives no considerable lateral fibrils to the walls of it. As to how the auditory nerve ends in the membraneous labyrinth at this period nothing is known.

In an anencephalous fœtus described by Hyrtl,[†] the cochlea was represented by a cavity, from the base of which, corresponding to the internal meatus, there rose a pyramid composed of canals and extended to the roof of it. This pyramid and the canals composing it were the representative of the axis and its canals for the transmission of the fibrils of the cochlear nerve. There was no trace of a turn of the cochlea nor of a lamina spiralis.

We now enter into a more explored region, viz. the progress of ossification in the labyrinthic shell, and for the knowledge we possess on the subject we are chiefly indebted to the late J. F. Meckel.[‡]

The osseous labyrinth is at first merely membraneous; by-and-bye it becomes cartilaginous, and lastly ossifies. The membraneous labyrinth has not been properly distinguished from it. The former at first lies free in the cavity of the cranium; the latter has never been observed in an uncovered state.

The development of the osseous labyrinth is quite distinct from the formation of the bony substance of the petrous bone. The latter commences before the former.

Ossification commences in the labyrinth towards the end of the third month round the fenestra rotunda, first at the upper part, then at the lower part; and when a ring of bone has thus been produced, ossification extends forwards. At the same time that the process just described takes place, another osseous nucleus, quite distinct from the preceding, is developed at the outer extremity of the superior vertical semicircular canal; there then appears a third small scale nearly in the middle of the posterior vertical semicircular canal. Proceeding from the first nucleus of bone, ossification makes rapid progress backwards and downwards; whence the floor of the labyrinth is form The second nucleus enlarges perhaps ev more quickly than the first, so that the who superior vertical semicircular canal is soon o sified, with the exception of its lower concav surface. From the inner extremity of this s micircular canal ossification extends on t inner surface of the petrous bone, circu scribes the internal auditory meatus, penetr into its interior, and forms the base of cochlea. In the fifth month ossification e tends from the two first nuclei to the horizon semicircular canal.

In the ossification of the cochlea, that of petrous bone has but a very small share that the petrous bone contributes is me thin prolongation which it sends betwee turns of the cochlea. This process is at broader than at a subsequent period. the third month, as the cochlea widens without inwards, the process in question comes thinner, and, at the same time, are dev loped the less considerable projections w separate externally the first external turn a half of the cochlea from each other.

The ossification of the labyrinth has be found imperfect; thus Krombholz[*] relates case in which he found the semicircular ca as well as both scalæ of the cochlea, presen the same thinness of walls as is remarked in fœtus. Some places were merely membraneo I have already mentioned that the aquedu are sometimes unusually wide, a circumstan conceivable when we consider the mode which most likely they are developed, which was spoken of when considering th In certain of the lower animals, such as pig, they are naturally wide.

At first the osseous labyrinth is quite tinct from the mass of the petrous bone, which it is, as it were, embedded. Its o surface is, up to the fifth month, quite smoo the corresponding inner surface of the osse mass of the petrous bone is smooth also, not so much so. The two surfaces are confounded together, although the spongy cell structure of the petrous bone can still, even some time after birth, be easily enough remo from around the hard bony substance of the la rinth. Afterwards they become insepara though it is still possible to perceive a t of the line of demarcation between th especially in the cochlea.

All the above circumstances show that osseous labyrinth, though in the petrous b is not of it; and that, as has been already sai cannot be affirmed to belong to the skeleton, to be merely embedded in a bone which d Moreover as Weber[†] remarks, the osseous l rinth is not in all animals enclosed in the sa bone of the skull; for in fishes, when a trace of osseous labyrinth is yet to be found, the se circular canals, or the rudimentary represe tive of them, are situated in the occipital b

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[*] Op. cit. p. 208.

[†] Op. et loc. cit.

[‡] Op. et loc. cit.

[*] Mücke, kurze Uebersicht der gegenwärti stehenden Lehr-und-Erziehungsanstalten für T stumme u. s. w. Prag. 1827, p. 19.

[†] Hildebrandt's Anatomie. Bd. iv. p. 40.

evelopment and irregular conditions of
anum and external ear.

the tympanum and its contents.

e cavity of the tympanum.—A prolon-
diverticulum of the mucous mem-
the throat, extending to the periphe-
ce of the labyrinth, and forming, with
end, a dilatation there, gives us the
idea of a tympanum and Eustachian
ccording to Huschke*—and his views
e or less supported by Burdach,†
and Valentin,§—the cavity of the tym-
ith the Eustachian tube is a metamor-
remains of the first branchial fissure.
its origin, the tympanum has nothing
on with the labyrinth.

in|| found the Eustachian tube and
the tympanum, in an embryo at the
veek, under the form of a conical or
l fossa. This fossa gradually extends
be, at first short and wide, but after-
ger and narrower in proportion as the
the tympanum becomes developed,
des from the cavity of the mouth.
achian tube is at first simply membra-
About the middle of pregnancy, ac-
to Meckel¶ and Burdach,** the third
ccording to Valentin, it acquires a
ous investment.

lind membraneous pouch which repre-
cavity of the tympanum is at first
ll and contracted, and is to be distin-
rom the walls of the tympanum, which
s. The peripheral surface of the laby-
ns, as is known, the inner solid wall
mpanum, and the tympanic ring and
a tympani the outer wall. In pro-
herefore, as these parts, and also the
process are developed, so does the tym-
vity acquire its proper form, and is
l more withdrawn, both from the cavity
nouth and the lateral surface of the
h the integument of which it is, at an
iod, in contact.

olongation of the mucous membrane
harynx forming the Eustachian tube
ty of the tympanum, is at first very
soft, and loose, like the mucous mem-
the nasal and guttural cavities; but
h it loses its vascularity, and assumes
simple character. United by loose
issue to the subjacent osseous wall, it
tself over all the elevations, and dips
depressions of it, and moreover forms
hich the ossicles are enveloped. The
f the tympanum is in the fœtus filled
nucus, sometimes transparent, sometimes bloody, and varying from the consistence of water to that of a thick jelly.

The cavity of the tympanum has been found sometimes unusually contracted; sometimes, on the contrary, very much dilated. Non-development of the Eustachian tube would be necessarily attended by non-development of the tympanum, but not contrariwise. Absence of the Eustachian tube and cavity of the tympanum has only been found in fœtuses, in other respects monstrous.

In describing the development of the osseous labyrinth, it has been already mentioned that its peripheral surface, which forms the inner solid wall of the tympanum, begins to be ossified towards the end of the third month. An ossific point first appears on the promontory at the circumference of the cochlear fenestra, and gradually extends upwards, downwards, forwards and backwards. At this time there is no trace of mastoid process. In the fourth month the *sinuositas mastoidea* begins to appear, and the cavity of the tympanum becomes somewhat wider. The aqueduct of Fallopius is not yet ossified, nor the canals for the muscles of the stapes and malleus, a state of parts found permanent in most of the lower mammifera, and also frequently met with in the irregular conditions of the ear in man. When the cochlea is arrested in its developement, the promontory is small in proportion or entirely wanting.

In the fifth month the aqueduct of Fallopius and the canals for the muscles of the stapes and malleus are ossified. In this month, also, the vestibular fenestra is found completely formed, and appears proportionally larger than in the adult. In the sixth month, the temporal bone being altogether more developed, and the mastoid process having begun to appear, the cavity of the tympanum increases in capacity, especially its upper part, and the *sinuositas mastoidea.* The direction and situatiôn of the cochlear fenestra vary much at the different periods of formation, which is owing chiefly to the degree of development of the promontory.

The vestibular and cochlear fenestræ are sometimes found unusually small, or even entirely wanting, the latter being obliterated by an extension of osseous substance, the former by the same cause, or by anchylosis of the base of the stapes. The cochlear fenestra sometimes appears to open into the vestibule, but this is when the cochlea is in a very rudimentary state. Such a condition may be compared with the state of parts found in the bird's ear.

Little or nothing is known of the origin and development of the membrana tympani. It may be looked upon as the persistence of that septum which exists at an early period at the opening of all mucous canals, and which is produced by the meeting of the indentation inwards of the skin with the diverticulum of the mucous cavity of the blastoderma. The membrana tympani is larger in proportion, and more vascular the younger the fœtus is. The form, situation, and direction of it in the fœtus is dependent on the tympanic ring, and is quite different from what is found in the adult. In regard to form, it is rounder. As to situation

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von Oken, Jahrg. 1827, p. 401; Jahrg.
61; Jahrg. 1831, p. 951; and Meckel's
ir Anatomie und Physiologie, 1832, p.

Physiologie als Erfahrungswissenschaft.
465.

physiol. Untersuchungen über den Kiem-
t und das Zungenbein, 1832, p. 120.

lbuch der Entwickelungsgeschichte des
n, p. 211.

p. 211 and 212.

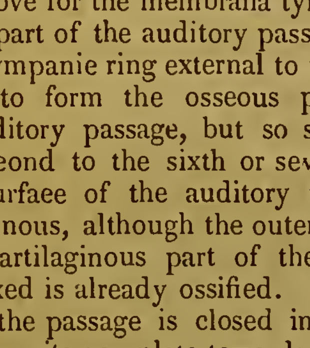
uel d'Anatomie, &c. tom. iii. s. 1948, p.

cit. Bd. ii. p. 465.

the osseous portion of the auditory passage not being yet developed, the membrana tympani is found at first closer to the surface than afterwards; and its direction is oblique from above downwards, and from without inwards, so that it has a more or less horizontal position, corresponding to the base of the cranium.

More is known of the origin and development of the tympanic ring in which the membrana tympani is framed. It appears later than the membrana tympani and the ossicles. A specimen of the tympanic ring before me, which was removed from an embryo at about the third month, is an incomplete ring of bone about one-tenth of an inch in diameter. It is about the thickness of a hair, except at its anterior extremity, which is broad and flat like a spatula, for the extent of about one-twelfth of an inch. The groove for the membrana tympani can be perceived with a magnifying glass. From the fifth month the tympanic ring is found more or less adherent to the rest of the temporal bone. In the lower Mammifera there are three parts developed from the tympanic ring, viz. 1, the groove for the membrana tympani, 2, the *bulla ossea*, and 3, the osseous part of the auditory passage. In birds the tympanic ring is represented by the *os quadratum*. In man there is no bulla ossea, only the groove for the membrana tympani and the osseous part of the auditory passage. The side of the tympanic ring external to the groove shoots out to form the osseous part of the external auditory passage, but so slowly that from the second to the sixth or seventh year, the lower surface of the auditory passage is still cartilaginous, although the outer orifice to which the cartilaginous part of the auditory passage is fixed is already ossified. About the twelfth year the passage is closed in by bone, and becomes quite complete towards manhood. The inner surface of the ring grows a little at the lower part, and helps, together with a process which extends from the petrous bone, to form the lower wall of the tympanic cavity. It is to be remarked that this inner part of the tympanic ring always remains distinct and is never changed so much as the external.

Fig. 30.



The tympanic ring, and the membrana tympani framed into it. The handle of the malleus is seen shining through the membrane.

The whole outer wall of the cavity of the tympanum has been found wanting in a monstrous fœtus. Hyrtl, who mentions the case, says that the cavity of the tympanum itself was represented only by a very shallow depression in the petrous bone, in which th
the auditory passage formed a cul-de-sac. T
Eustachian tube was present. Hyrtl mentio
another case in which the tympanic ring w
much smaller than usual, and in which
membrana tympani presented in the directi
of one of its radii, a large opening as if
piece had been cut out. The so-called *hia*
Rivinianus ought, perhaps, to be looked u
as Huschke observes, as a defect in ori
formation. The membrana tympani has b
sometimes found congenitally too large, so
times too small, sometimes of an elong
form, sometimes of a triangular form.
thickening and parchment appearance
membrane, or ossification of it to a grea
less extent, if not always, appears to be
usually an acquired malformation.

2. *The small bones of the tympanum.*—T
small bones are formed at a very early per
The malleus and incus appear before t
stapes. The two former, according to Ra
and Valentin, appear like a small wart grow
out from the posterior wall of the tympan
The stapes is like a growth from the outer
face of the labyrinth; it appears as a s
pyramidal wart flattened on the sides and
in the middle, lying, according to Rathke,
a small funnel-like depression, the botto
which is the future vestibular fenestra.

According to Weber[*] the ossicles are
developed in the cavity of the mucous m
brane of the tympanic cavity, but in a
which is a continuation of the dura mater,
comes through a fissure between the pe
bone and the squamous portion of the t
poral into the tympanic cavity. This situa
of the ossicles at an early period corres
with that of those discovered by Weber in
fishes already mentioned. By this mod
development, as far as regards situ
may be explained the dislocated state of
ossicles so frequently found in the irreg
conditions of the ear.

According to Meckel,[†] the ossicles ar
the commencement of the third month
portionally very large, though still cartilagi
and the stapes not to be distinguished from
incus. Thus, for example, the length of
malleus in a fœtus of the fourth month am
to three lines, whilst the length of the
from the vertex to the coccyx measures
inches, hence the lenght of the malleus
that of the trunk as one to sixteen; wh
in the adult the proportion is only as o
ninety, the malleus being four lines long
the distance between the vertex and the c
amounting to two-and-a-half feet. At
the ossicles are as large as in the adult.

Ossification of the small bones comme
according to Burdach,[‡] about the twelfth
Rathke and Valentin agree with Meckel
ossification begins first and at the same ti
the malleus and incus, and only afterwa
the stapes. In the malleus the first po
bone appears on the head, a second at th

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[*] Hildebrandt's Anatomie, Band. iv. p. 3

[†] Op. cit. tom. iii. p. 197. s. 1948.

[‡] Op. cit. Band. ii. p. 384.

long process. In the incus the first
ossification occurs in the longer crus
e body, and from this point it extends
he fourth and fifth months, so far that
le is ossified with the exception of the
f the short process. The long crus
always found completely ossified,
ie short crus was still cartilaginous.

stapes is still cartilaginous when ossi-
has made considerable progress in the
o bones. According to Meckel ossi-
locs not commence at any determinate
the stapes; only he never observed it
he head. According to Rathke there
particular nuclei, one for each of the
the triangle which the stapes repre-

pening between the crura of the stapes
st very inconsiderable,—a condition
s to what is found permanent in the
&c.

ssicles are not unfrequently irregular
form, size, and situation. They may
wanting. The stapes, as it is the last
presents the most numerous and most
alformations; the malleus the fewest.
pes has been found, by Tiedemann,
at first, like a pyramid without any
; again, it has been found with but a
ll opening, or presenting indeed the
it the space between them filled up
n plate of bone. Only one crus has
nd rising from the middle of the base
rm of a slender pedicle of bone as in
and presenting no trace of an articular
r the reception of the lenticular pro-
he incus, &c.

arkable circumstance connected with
y formation of the malleus is the
, as Meckel* first observed, of a
cartilaginous process, having the
a very elongated cone, which ex-
om the anterior part of the head
nalleus to the place where the two
f the lower jaw unite in front. The
ous process passes out of the cavity
ympanum between the petrous bone
panic ring. This process, though
nuch the same situation, must not be
led with the *processus gracilis*. The
es above the latter, and both parts are
stinct from each other. Moreover the
ous process never ossifies, but dis-
in the eighth month. Huschke† has
d a similar process extending be-
e short crus of the incus and the supe-
of the hyoid bone through the me-
the styloid process.

The most interesting irregular formation of the malleus is what appears to be connected in some manner with the above described early condition of the malleus and incus. Such cases are related by Hyrtl,* Heusinger,† and Hesselbach.‡

2. *Of the external ear.*—The external ear soon disappears in the animal series. It is the last part of the apparatus of hearing which makes its appearance in the human embryo. It is very subject to irregular development. It is only about the middle of the second month that a trace of it can be observed. It is at first merely a slight elevation of the skin, broad above, narrow below. In the middle of this elevation is a longitudinal fissure of the same form, which is narrower and at the same time deeper from above downwards. The prominence soon becomes more elevated and thinner at its posterior part, and projects above the surface of the side of the head, from which circumstance the middle depression is a little exposed. At the same time or soon after, the anterior part of the prominence is found divided into two halves by a transverse fissure running forwards; the inferior half is the antitragus, and the superior the commencement of the helix. At the same time this anterior part of the external ear rises also, and the posterior spreads more out. In the third month the anthelix and tragus are developed; the concha is not yet perfectly distinct; it is only indicated by the middle depression. In the fourth and fifth month the hollow of the concha appears, and is completely formed in the sixth. The lobule is the last part which presents itself.

The cartilage begins to be formed in the third month, but is developed slowly. Towards the end of pregnancy, though thicker, harder, and firmer, it is still incomplete.

The cartilaginous portion of the auditory passage as well as the auricle is at first proportionally much smaller than afterwards. The skin lining the auditory passage is softer and thicker than in the adult, and is covered with a thickly set down. In the fœtus the auditory passage is rounder, straighter, and shorter than in the adult.

The auricles may not be formed at all, or their development may be so arrested that they shall be represented merely by unshapely folds of skin with or without cartilage, or they may deviate more or less from their usual form, size, and situation. Imperfect formation of the auricle is frequently accompanied by absence or closure of the auditory passage. Professor Samuel Cooper mentions the case of a child in which there was not the slightest trace either of external ear or auditory passage.

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cit. tom. iii. p. 199. s. 1948. See also
Beiträge zur Physiologie und Natur-
e, p. 48. Taf. ii. Fig. 1. Isis von Oken,
eft. vii. p. 678. Serres, Annales des
Naturelles, 1827, p. 112. Weber, Hilde-
Anatomie, 4te. Ausgabe. Band. iv. p. 47.
op. cit. p. 122, and Valentin, op. cit.

von Oken, loc. cit. and Valentin, op. et

* Op. et loc. cit.

† Specimen malæ conformationis organorum auditus humani rarissimum et memoratu dignissimum, cum tribus tabulis æri incisis. Jenæ, 1824.

‡ Beschreibung der pathologischen Präparate, welche in der königlichen anatomischen Anstalt zu Würzburg aufbewahrt werden. Giessen, 1824.

Sometimes, however, the auditory passage has been found regular though the auricles were wanting.

The auditory passage is sometimes found too wide, sometimes too narrow, sometimes too short. Closure of the auditory passage may be either partial or through its whole extent. It is more rarely the effect of disease than of irregular primitive formation. Partial closure may be by an extension of the skin over the mouth of the passage. Authors mention cases of a membraneous septum sometimes deep in the auditory passage and before the membrana tympani, sometimes nearer the entrance of the passage.

In monstrous fœtuses all the accessory parts of the apparatus of hearing together have been found wanting.

II. PARALLEL BETWEEN THE EAR AND THE EYE.

A parallel has often been drawn betwixt the ear and the eye. Breschet, in his memoir, already so often cited in the course of this article, compares the perilymph to the aqueous humour, the endolymph to the vitreous humour, and the calcareous concretions to the crystalline body.

The comparison which I should institute between the component parts of the ear and the eye is the following:—

The osseous labyrinth may be compared to the sclerotica, and the fenestra rotunda, or cochlear fenestra, to the cornea.

To find a part in the eye analogous to the vestibular fenestra, we must first consider that the latter is a yielding part of the otherwise solid wall of the labyrinth; that through the medium of it, the chain of small bones and their muscles in the tympanum exercise on the soft parts contained in the labyrinthic cavity, a certain degree of tension or compression fitted probably to accommodate in some manner the ear to the perception of different degrees of sound. In the case of the eye, the sclerotica, which corresponds to the osseous labyrinth, is thinner and more yielding at the middle of its circumference, (remarkably so in the Greenland seal). From this it has been supposed that the action of the muscles of the eye-ball might by their compression produce a change of shape fitted to accommodate the eye to distances. Hence the vestibular fenestra and middle thin part of the sclerotica might be compared to each other in as far as regards the function which each performs in the economy of its own organ. However this may be, the vestibular fenestra of the ear and the thin part of the sclerotica correspond to each other as far as can be in relative position; and if we admit the action just mentioned of the muscles upon the eye-ball, we have, as I shall immediately show, their counterparts in the muscles of the small bones of the tympanum.

The tympanic scala of the cochlea may be compared to the anterior chamber of the aqueous humour, and the vestibular scala to the posterior chamber.

The spiral lamina, considering its vas larity and richness in nerves, and its forming a partition between two chambers containing an aqueous humour, may, as I have already said in a former part of this article, be considered the counterpart of the iris, and th helicotrema that of the pupil.

The membrane lining the labyrinthic ca bears the same relation to the latter as *arachnoidea oculi** does to the sclerotica. T space filled with perilymph, between the o ous and membraneous labyrinth, may be c sidered analogous to that between the scler and choroid. It however communicates the scalæ of the cochlea, the parts analog to the chambers of the aqueous humour cause there is nothing in the ear to be c pared to the ciliary ligament.

Forming the membraneous labyrinth we fi 1. a delicate cellular tissue supporting th branches of the bloodvessels, and which sometimes found containing black pigmen 2. a firm transparent membraneous coat, w which, 3. is a nervous expansion; 4. the en lymph; 5. suspended in the latter the mass calcareous matter. The cellulo-vascular la containing pigment, together with the rest the walls of the membraneous labyrinth, be compared to the choroid coat of the e the nervous expansion to the retina, the e lymph to the vitreous humour, and the ca reous mass to the lens.

In the lower animals the cochlea is the part of the ear-bulb to disappear; in regard the eye-ball, the aqueous chambers to w I have compared the scalæ of the cochlea, in like manner the first parts which in the preciation of the structure of the eye, i animal series, disappear, e. g. the eye of t Cephalopodous Mollusca.

Is the cochlear nerve the same in fun with the vestibular? The vestibular nerve the special nerve of hearing; but does not cochlear nerve perform some function i economy of the ear analogous to what ciliary nerves perform in that of the eye?

If an example is required in which the o nervous filaments enter the eye separate do the nervous filaments of the ear-bulb, to be found in the Cephalopodous M lusca.†

As in front of the eyeball there is, or ra would be, if it was not that the eyelids constantly in contact with the eyeball, a s lined by a mucous membrane, the conjunc so at the peripheral surface of the ear- there is a space, the *tympanic cavity*, lin a mucous membrane also. Moreover, as t is a passage into the nose from the s bounded by the conjunctiva, so does the

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* See my figure and description of a hori section of the human eye, in Mackenzie's Pra Treatise on Diseases of the Eye. *Second E* London, 1835.

† See a paper "On the Retina of the C fish," in the London and Edinburgh Philoso Magazine for January, 1836.

vity communicate with the throat by
ıchian tube. In the tympanic cavity
ı chain of small bones, articulated to
ıer and moved by muscles, which
› produce some change in the state of
of the soft parts of the ear-bulb; in
ınctival space there is nothing analo-
though, without pushing the point too
night compare the muscles of the eye-
h those of the ossicles of the tym-
both being equally, in fact, *outside*
pective mucous membranes. In re-
the ossicles I would remark that,
g to the views of Weber,* they must
ıned among those which do not belong
keleton, and which are of very incon-
currence. Such are the bone of the
ı many animals, the teeth, *the ring of*
ıtes round the front of the sclerotica of
's eye, &c.
t in the composition of the appendages
eye analogous to the membrana tym-
only to be conceived by supposing the
e of a *mediate anchyloblepharon*, that
rregular membrane stretched between
es of the eyelids, uniting them toge-
. closing in the space lined by the con-
, which space would now communi-
th the exterior, only by the lachrymal
ıles and nasal duct, in the same way
tympanic cavity communicates with
erior only by the Eustachian tube. A
tal fissure or total absence of the mem-
ympani is an irregularity of structure
ear, which may be compared to what is
in the eye. A mind accustomed to
ıalogies will perceive a resemblance:—
external auditory passage in that short
t the opening of the eyelids extending
e inner edge of the tarsal margin to the
to the ceruminous glands in the Mei-
follicles; and to the hairs at the en-
of the auditory passage in the eyelashes.
ricle, if it is necessary to look for a part
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